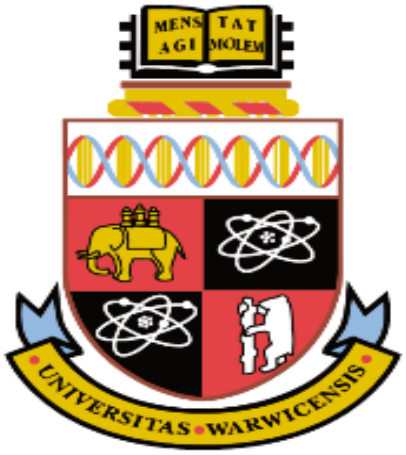

A Micro Note Taking Approach: The Student Experience

By

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A thesis submitted in partial fulfilment of the requirement for the degree of

Doctor of Philosophy in Computer Science

Supervisors

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To each of the above, a heartfelt thank-you.

To my loving and supportive family

My husband, **Mazin**

My sons **Wabil** *and* **Hattan**

Words are not enough to express my appreciation

of the part you have played during this journey we have **all** been on

Declaration

This thesis is submitted to the University of Warwick in support of my application for the degree of Doctor of Philosophy. I hereby declare that, except where acknowledged, the work in this thesis has been composed by myself, and has not been submitted elsewhere for the purpose of obtaining an academic degree.

Maram S. Al Zaidi

Signature: _____

Date:_____

Glossary

Mobile devices in this research refer to smartphones that are carried by students in the classroom.

Micro notes are short texts of notes (140 character) that are created using the short content creation feature of microblogging.

Microblogging refers to a Web 2.0 technology that contains two main features: short content creation and social communication.

Short content creation refers to the short content created by users, usually 140 characters for each chunk of information.

Twitter is a social network platform that is built on the technology of microblogging.

M2NT A new developed application within this thesis based on the short content creation feature of microblogging for note taking in the classroom.

Publications

Below, the conference papers published from this PhD research are listed:

1. **Al-Zaidi, M.S**., Joy, M.S. and Sinclair, J.E. (2013) Exploring the Use of Micro Note-Taking with Social Interaction Features for Education. In: International Conference on Education and New Learning Technologies (EDULEARN13), 1-3 July 2013, Barcelona, Spain. (In Press)
2. **Al-Zaidi, M.S.,** Joy, M.S. and Sinclair, J.E. (2014) Micro Notes Application for Education: a Proposed Mobile Micro Note-taking Architecture. In: 13th European conference on e-learning (ECEL 2014), 29-30 October 2014, Copenhagen, Denmark. (In press).
3. **Al-Zaidi, M.S.**, Joy, M.S. and Sinclair, J.E. (2016) Micro Note-Taking on Smartphone: The Learner Experience. In: 8th international conference on mobile, hybrid, and on-line learning (eLmL 2016), 24-28 April 2016, Venice, Italy.

Abstract

Note taking is one of the most widely-practised and commonly used activities among students in the classroom. However, despite the massive advancement of technology in education, pen and paper still seem to be the (most) favoured note taking approach among students. This, however, could be the result of not having note taking technology that provides students with relative advantages and substantial value in comparison to pen and paper. On the other hand, social media has been growing in popularity. Short messages can be easily conveyed via microblogging applications, such as Twitter. Therefore, the research aims to investigate the effect of using the short content creation feature of microblogging (140 characters) as a note capturing approach in the classroom.

This research adopted a design science research methodology consisting of three phases. The first phase, *investigation*, reviewed the literature and conducted an exploratory study. The literature review showed that there is an increased interest in using technology for learning activities. However, the existent technological support for note taking, in particular, is not popular. In addition, an exploratory study was conducted with 254 undergraduate students at the University of Warwick. The study showed that students had a lack of interest in taking notes using current note taking application on their mobile devices. Hence, to tackle this issue, the *development phase* proposed a micro note taking mobile application to support students' note taking at university-level. In addition, this phase included the development and implementation of the mobile micro note taking application (M2NT) based on microblogging technology for data collection purposes.

Finally, the *evaluation phase* included a main experiment conducted with 42 students using three types of note taking approach (i.e. pen and paper, word processor, and the micro note taking application). This was followed up with questionnaires distributed to students after experiencing each note taking approach. In addition, the experiment ended with a final comparison questionnaire and focus group discussions. Furthermore, the students' micro notes and their feedback were analysed to investigate the implications of mobile micro note taking.

Analysis of the data provided insight into issues related to students' note taking activity, as well as an evaluation of students' experiences and the perceived usefulness of note taking using a micro note taking mobile application. Additionally, the research findings showed that using the developed mobile micro note taking positively supported the students' experience and perceived usefulness of the practice of note taking. Future research directions and recommendations are discussed at the end of this research.

Chapter 1

1 Introduction

1.1 Research Background and Motivation

The main aim of this research is to support students' note taking activity at university level by effective utilisation of advanced mobile and Web 2.0 technologies. Note taking is a common activity used by students during lectures [1]. In addition it is an important technique used in learning processes that has been demonstrated to have a positive impact on student achievement [2]. Traditionally, this course of action by students has been conducted manually, using pen and paper. Additionally, the pen and paper method still seems to be the most favoured means of capturing notes in the classroom [3].

However, taking notes using mobile devices remains unpopular among students in the classroom. This could be the result of not having a mobile note taking technology that can provide students with relative advantages and substantial value, in comparison to the traditional pen and paper approach. Furthermore, with massive uptake in the domain of information and communication technology, there is considerable potential for integrating new technologies with the learning activities at universities, and specifically for note taking, in ways that can eventually lead to a more effective note capturing experience.

Accordingly, this research involves the integration of note taking from the education discipline with mobile and Web 2.0 technologies. This is achieved by developing a new note taking approach based on the employment of the short content creation feature of microblogging in a mobile application. This thesis postulates that the use of innovative technologies in providing a new approach for note taking practice would be fruitful for students.

There has currently been a noticeable increase in the number of students carrying mobile devices into the classroom, including laptops, smartphones and tablet devices. Sharples [11] highlighted the growth in the use of mobile phones amongst students as well as across all educational areas. New generations of smartphones support fast Internet connections through 3G and 4G wireless technology, in addition to faster Wi-Fi connections. Moreover, with new iPhone and Android phones providing millions of applications, there has been a dramatic increase in interest levels in using these devices for education [12]. Indeed, in the last decade, and due to these advances, researchers have shown an increased interest in using new technologies and computing devices in note taking practice.

Microblogging is a new form of publishing and sharing content ([4][5][6]) that falls under the umbrella of Web 2.0 technology and is becoming an emergent promising tool in education [7]. Moreover, microblogging is increasingly gaining interest among researchers in mobile learning [6]. In addition, many researchers have argued that microblogging has high potential to enhance learning [178].

One of the main features behind microblogging is that it allows users to post brief online messages that are limited to 140 characters [8]. Twitter is seen as one of the most popular microblogging platforms that has been used for educational purposes. In addition, the majority of research in the field of microblogging in higher education has focused on Twitter as a support tool for learning [94].

Tang and Hew [95] examined a decade (2006 - 2015) of research on how Twitter has been used in education. They identified six ways of using Twitter in education: capturing, communication, collaboration, class organisation, assessment and reflection. Moreover, they found that Twitter was used mainly as a communication and assessment tool. However, only two studies from a total of 51 publications ([96][119]) focused on using Twitter as a capturing tool. Moreover, Tang and Hew [95] suggested future research to

examine specific education activities that could be supported by using short content creation. In addition, Gao et al. [178] examined 21 publications in educational microblogging between 2008 – 2011, and found only one experimental focused study, while the remaining were descriptive focused.

Therefore, based on these two recent comprehensive reviews [178] and [95], it is clear that further research is needed when using microblogging in education activities. Additionally, current research has given little attention to the capturing activity (i.e. short content creation) of microblogging.

This research seeks to understand the activity of note taking from the students' perspective, and develop a new mobile micro note taking application to support students' note taking experience. This is achieved by using the microblogging feature of short content creation in a mobile application to produce a new educational note taking approach called 'micro notes'.

1.2 Research Problem

This research addresses the following problems related to note taking activity:

- The current note taking approach of using traditional pen and paper produces incomplete and inaccurate notes which may not provide students with the best note taking experience ([15][16]);
- There is lack of mobile note taking application usage for education purposes, despite the fact that Smart phones are popular ([11][12]);
- There is lack of research in the use of advanced technologies for note taking practices in the classroom environment, despite its significance ([3][18]).

This research addresses the stated problems related to current note taking practice and investigates the Web 2.0 feature by supporting students with a developed research based

approach. This is then evaluated through a mobile note taking application using microblogging that has been designed and implemented by the researcher. The perceived experience of students is measured based on students' interaction with the mobile note taking application, using the short content creation feature. These problems will be addressed through an extensive literature review in the field of note taking. Next, the current note taking from the perspective of students towards note taking in mobile applications will be investigated. A new note taking approach using Web 2.0 technology will be used and evaluated via an implemented note taking application on Android-supported smart phones, called mobile micro note taking, to access students' experience as well as students' perceived usefulness. It is deemed that this research will contribute to the Web 2.0 feature of the employment of microblogging short content creation for note taking on smartphones, and investigate students' experience compared to what has been the case hitherto with either traditional pen and paper or electronic word processor applications. In addition, for better understanding of the features and factors influencing the students' experience while note taking through microblogging, the short content creation feature is explored.

Accordingly, this thesis will contribute to the literature by evaluating the short content creation feature of microblogging for note taking activity in relation to the experience of students, and in addition, this research touches on practice of usefulness [19][20] to create a list of features affecting both measurements. Further details of the measurements can be found in Chapter 5.

1.3 Research Questions and Objectives

In order to address the research problem, this research aims to answer the following main research question: **How does short content creation on a mobile application influence students' perceived experience?**

The research question can be broken down into the following three sub-questions.

- RQ1: What are the students' perspectives regarding mobile note taking applications in the classroom?
- RQ2: What is students' perceived experience and usefulness of using a mobile micro note taking application in comparison to traditional pen and paper and electronic word processors?
- RQ3: How does using a mobile micro note taking application affect students' perceived experience and their perceived usefulness in practice?

This research aims to investigate the effect of using the microblogging short content creation feature (140 characters) as a note capturing approach for note taking practice in the classroom environment in terms of perceived usefulness and students' experience. In order to answer the research questions, the following objectives need to be achieved.

OB1. Review the literature in the field of note taking activity in the classroom environment and the use of advancement of technologies in education for learning activities.

OB2. Conduct an investigative study that explores current students' note taking and propose a new way of note taking.

OB3. Design and implement a mobile micro note taking application along with the identified gap in literature, as well the outcomes from the investigative study. This is to be used for data collection purposes.

OB4. Conduct an experimental study to collect data relating to students' experience of using mobile micro note taking.

OB5. Evaluate the students' experience of using the mobile micro note taking application to better understand how limits such as the 140 characters of microblogging support note taking experience in mobile applications, and draw findings to make a final conclusive summary.

1.4 Research Scope

This research investigates students' experience of using a mobile micro note taking application as a note capturing tool in a classroom environment. Although students in the classroom carry more than one mobile device, they do not use these devices for note taking activities in the classroom. For instance, the students use their mobile devices to access Web 2.0 platforms.

Bearing in mind the advances in technology use in education, as well the features of Web 2.0 that could provide students the best experience for note taking in a mobile application, the focus of this research is mainly on investigating the experience of students in using short content creation of microblogging technology for note taking activities in the classrooms in mobile applications.

1.5 Research Design

Design Science Research Methodology was the main methodological approach adopted throughout this research. A methodology of design science research is extended for use in information systems research [123]. Design science research is based on a design history as a component of engineering and computer science research [123]. Design science… "*creates and evaluates IT artefacts intended to solve identified organisational problems*" [121, p.77]. The main component of design science is "*design and the proof of its usefulness*" [123, p.33]. In recent years, many researchers have succeeded in using design science research methodology in information systems research [121].

Since the goal of this research is to evaluate the students' experience and subsequently extend this evaluation to touch on the usefulness of a developed application to support students' note taking, design science research is deemed suitable. It is essentially a problem-solving process [121], which is appropriate for conducting research that aims to

produce solutions [121]. The development of a micro note taking application uses the short content creation feature of microblogging technology for note taking, which is adopted in this research to represent the new approach to note taking.

Offermann et al. [124] propose a research process for design science research in information systems. The three parts of Figure 1-1 below illustrate the phases that researchers can follow throughout the research process. This process has three main phases: the first phase is "*problem identification"*, the second phase is "*solution design"* and the third phase is "*evaluation"*. These phases can be summarised briefly as follows.

- **Phase1: Problem identification**

In this phase the problem is identified and an investigative study is carried out to explore the problem in depth. Throughout the first phase, a literature review is assessed, the problem is identified and what is relevant to resolving the problem is examined.

- **Phase 2: Design artefact**

In this phase, the solution is designed and implemented. During phase two, the literature supports the idea of the solution under review, the solution is designed and the previous literature review related to the research may be re-visited in order to increase the understanding by closely relating the problem to the designed solution.

- **Phase 3: Evaluation**

Evaluation is the third and final point of design science research methodology. Expert survey, laboratory experiment and case study/action research can be conducted in the evaluation phase. Hypotheses are refined in this phase. Additionally, phase one and phase two are re-visited if necessary when the process reaches the final phase.

The following Figure 1-1 illustrates the three parts of the research process. The phases have been divided into steps which are not necessarily in a sequential execution mode.

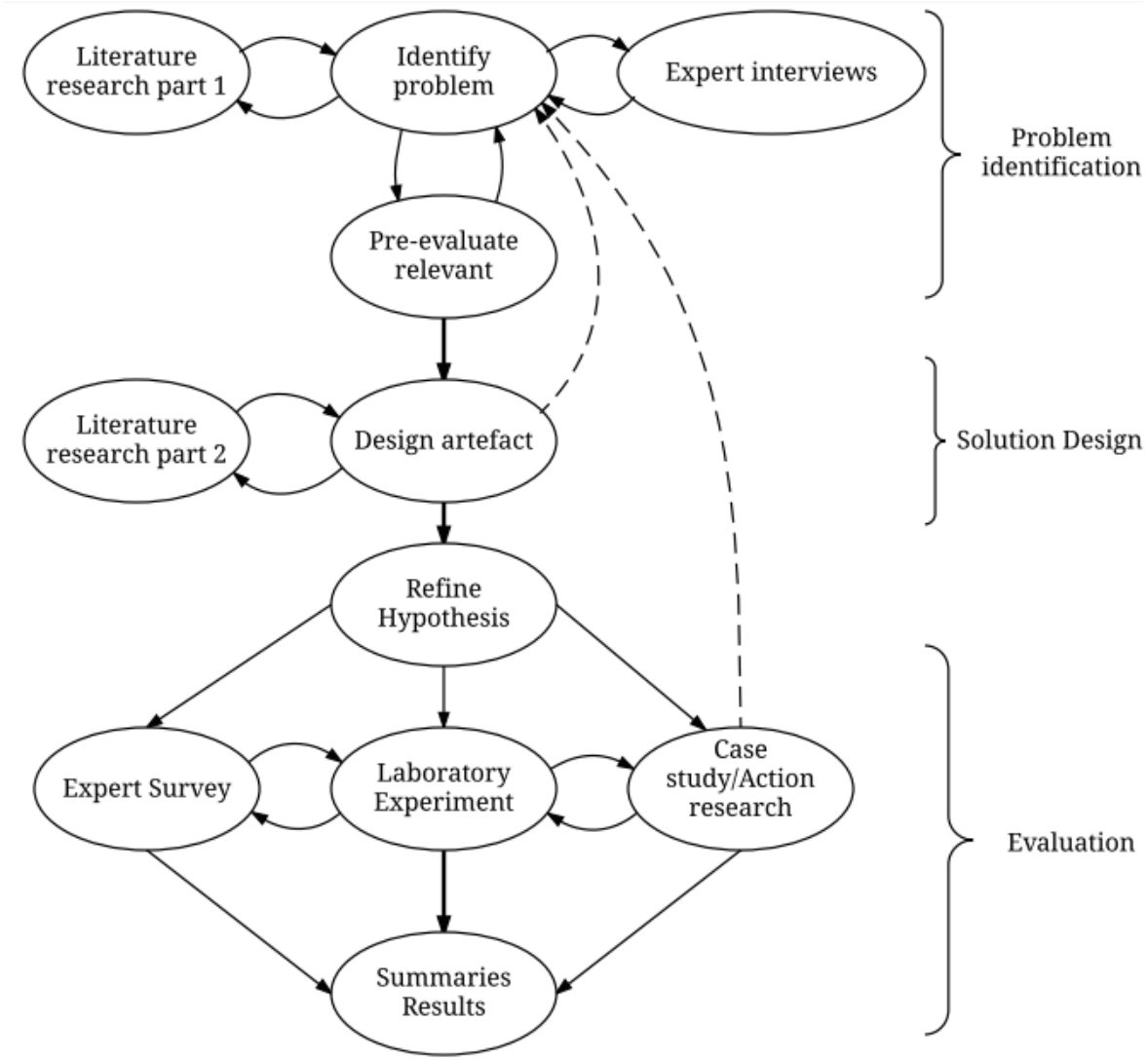


Figure 1-1: Design science research (Offermann et al. [124])

The bold arrows indicate the main transaction between the steps, whereas the dotted arrows indicate that the previous phases can be re-visited before the process starts in the next phase, if necessary. At the end of this execution process, design science research delivers comprehensive outcomes.

Design science research methodology has been chosen to conduct this research [124], because this work is rooted in the domain of information systems. The next section shows how the design science research methodology is applied in this thesis.

In the light of the design science research process discussed above, the following Figure 1-2 illustrates the three parts that have been used with slight changes to the methods and approaches for gathering the data to meet the current research process needs. The three parts of the phases deployed throughout this research are as follows.

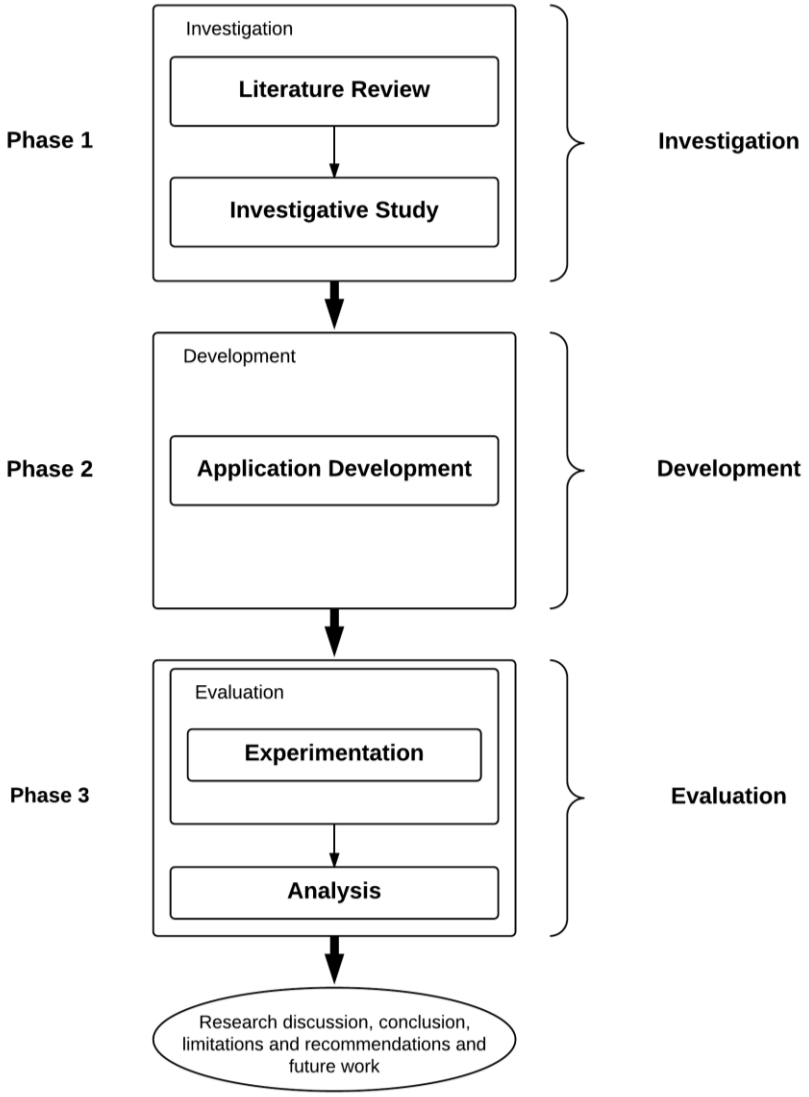


Figure 1-2: Research design with this thesis

1.5.1. Investigation Phase

In this phase, the literature review is the first step in the journey of any research. It works as a guidance approach to reviewing the research which has been conducted so far in the field of note taking activity. It aims to investigate the existing research on students' note taking activity and the associated technologies of note taking. Chapter 2 presents the literature review including note taking, note taking technologies, Web 2.0 technology, microblogging technology and previous related studies. In addition, an investigative study was conducted to explore current student note taking activities. Moreover, through the investigative study, students' opinions in relation to note taking were gathered to provide additional insights. The output of this phase resulted in identifying a need to design new approaches to support students' note taking experience. Thus, the insights from the first phase of the research contributed to the design of the proposed research application.

1.5.2. Development Phase

This phase involved the proposed application which was informed by the literature review on note taking practice, as well as new technologies employed in education, and the investigative study of current note taking activities, to contribute knowledge helping to fill the gap in the existing literature as discussed in Chapter 2.

The area of note taking activity using technology has been extensively researched to keep track of the massive development in the use of technology for note taking activity (Chapter 2). This work has developed an application that used a short content creation feature of microblogging technology for note taking activity on Android smart phones. The main reason for developing the application on only the Android platform was the open source nature of Android, compared to the restrictions and additional requirements to develop applications in Apple, for instance. This meant that the software can be reused easily. Another reason was that the availability of the resources on Android devices for the

researcher made the implementation and testing much easier. Furthermore, time limitation did not allow implementation on several devices consecutively, especially as the research gain would have been minimal. It was thus decided to develop the on-going application research on the Android platform, instead of other platforms. The research application was developed to support the data collection process.

Further details of implementation can be found in Chapter 4.

1.5.3. Evaluation Phase

Following the development of a mobile micro note taking application (M2NT) students were asked to use this application through an experiment. The evaluation phase is the final stage of this research. In this phase the implications of short content creation for note taking activity were extensively evaluated. The main aim of the evaluation was to evaluate the experience of students and their perceptions of usefulness of using the short content creation feature for note taking that was developed on smart phones.

Various methods were used throughout the evaluation to deliver comprehensive outcomes of the short content creation feature of microblogging technology for note taking. The new application was used as an experimentation tool evaluated throughout the experiment conducted within this thesis to collect and analyse students' experience. The target in this research is students' experience related to usefulness. A quantitative approach was used to analyse students' feedback on the three different note taking approaches (that are developed application (M2NT) and existing approaches: traditional pen and paper and electronic word processor). Moreover, a qualitative approach was used to understand the implications of M2NT. Therefore, data items were collected from experiment. These items are students' micro notes, focus groups and other qualitative feedback from students.

1.6 Thesis Outline

The thesis structure is as follows:

Chapter 2: Literature Review
This chapter reviews the state-of-the-art literature in this interdisciplinary research relating to note taking and the advancement of educational technology. In addition, it explores the new trends of technology existing in education for supporting learning activities. The chapter also identifies gaps within the existing literature of note taking activity.
Chapter 3: Investigative Study about Current Students' Note taking
This chapter explores the current students' note taking activity and identifies the perspective of students regarding integrating Web 2.0 features with mobile applications for note taking.
Chapter 4: Development for Mobile Micro Note Taking Application (M2NT)
Based on the literature review and the outcome from the investigative study conducted in the previous chapter, a Mobile Micro Note Taking application (M2NT) was formulated to fill the gap in the current state of the art as well as to fulfill the requirements extracted from the investigative study. This chapter describes the micro note taking application with a short content creation feature of microblogging as a desirable feature that has been explored in the investigative study. The chapter also describes the mobile micro note taking application (M2NT) used in this research as an experimentation tool.
Chapter 5: Evaluation of M2NT
After the mobile micro note taking was developed, data from students was required to evaluate the experience of students using a new format note taking approach proposed by the researcher. This chapter elaborates on the methodological approaches, methods and techniques that guide this research to collect and analyse the data.

Chapter 6: Results and Discussions
In the light of what students reported through the evaluation of mobile micro note taking the findings are discussed, this final chapter deals with the two sub questions. It discusses the results from the quantitative approach and the results from the qualitative one.
Chapter 7: Conclusions and Future Work
This chapter delivers the final conclusive findings for this research and highlights the research contribution of these findings. This chapter also outlines the limitations of this research, as well as pointing to directions for future work.

1.7 Summary

This chapter has introduced the main background of the study. The chapter has also defined the research problem and scope. In addition, the research questions, objectives and research design are presented. The following figure describes how the research questions are mapped to the research objectives across the research design phases. Finally, the figure shows where each objective is addressed, and in which chapter of the thesis.

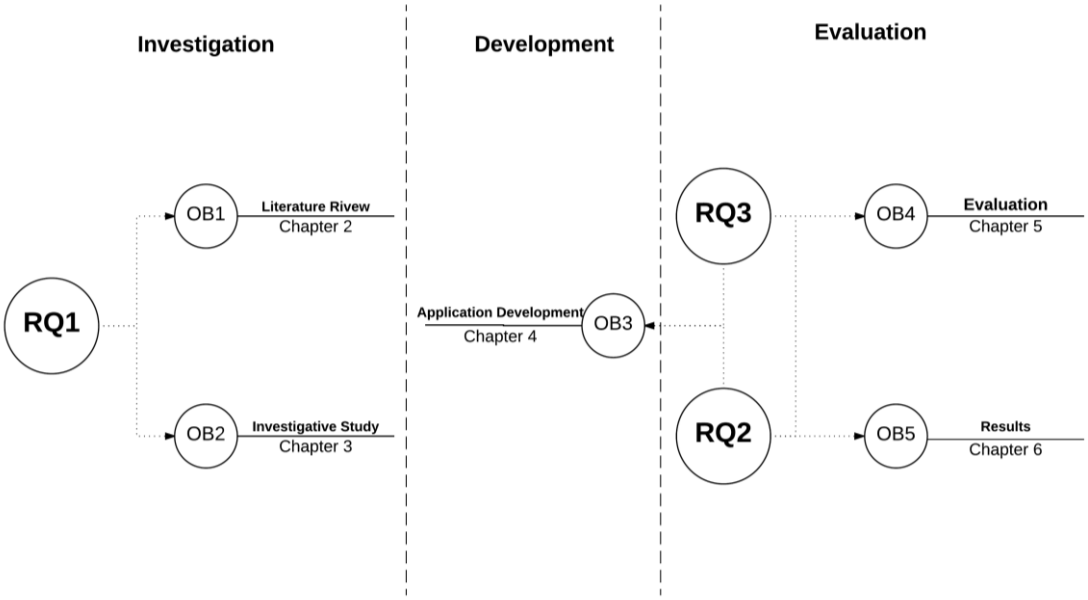


Figure 1-3: Mapping of research questions and research objectives across the research design

Chapter 2

2 Literature Review

2.1 Introduction

The literature review is the first step in the investigative phase of this research. The aim of this chapter is to explore current note taking activities. In addition, this chapter critically reviews the existing literature in order to develop a clear understanding of the related concepts and technologies. Moreover, the chapter reviews the previous related research in the field of note taking. It explores the state-of-the-art in the field of mobile technology, Web 2.0 technology, microblogging technology and different note taking approaches, in order to identify the existing gaps in the literature.

As previously mentioned in Chapter 1, this research is interdisciplinary in nature, and therefore, the focus of the reviewed literature consists of two areas: computer science (i.e. mobile technology) and education (i.e. note taking). Hence, this chapter explores the field of note taking practice in class, and highlights the use of technology for note taking activities in the classroom.

Accordingly, this chapter serves as an essential basis for the research, given that it formulates the theoretical background basis that the research is based upon. Additionally, the output of this chapter fulfils the **OB1** research objective.

2.2 Shift in Learning Style: From Traditional to Modern

Traditional learning based on memorizing and reproduction cannot meet the abilities and challenges required by modern society [22]. Despite recent rapid advances in mobile technology and the Internet, including Web 2.0 technology, traditional pen and paper seems to be the tool most utilised by undergraduate students for note taking practice.

This, however, could be the result of not having a note taking solution that can provide students with relative advantage and substantial value in comparison to the pen and paper approach. Therefore, a need has emerged to use innovative technologies so as to offer new ways for note taking practice that would help in achieving a positive student experience.

The web has dramatically changed almost everything, including the way in which we live our lives, the way business is conducted, and the way learning is practiced. According to Greenhow et al. [23], the nature of the web and contexts for learning have been altered, along with the emergence of the technological capabilities offered to students. Indeed, the Internet is becoming increasingly ubiquitous in schools, universities, homes, places of work and communication [23]. Accordingly, the domain of educational technology has emerged. Educational technology can be defined as "the study and ethical practice of facilitating learning and improving performance by creating, using and managing appropriate technological processes and resources" [24,p.283]. According to Kozma [25] using technological tools and resources within classrooms supports students' practices. This is in fact not a surprise, given that students in colleges are the heavy users and early adopters of the Internet [26] . Eighty six percent of college students are online, compared to fifty nine percent of the general population [26]. In fact, the role of technological competencies has replaced traditional rhetorical activities [23], thus enhancing college students' education.

With rapid advances in technology, there has been a massive shift in the way learning is practiced and the way educational tools are used. Indeed, many technologies have a powerful influence on numerous domains, including education [27]. For instance, students may choose to use an e-text for their learning on mobile devices as an alternative to traditional textbooks, thus effectively influencing their learning [28]. Mobile devices and PDAs are widely becoming natural tools used for mobile learning [29]. Moreover, there is a noticeable increase in the number of universities/colleges that offer courses using

mobile devices as alternative learning tools [30]. Mobile technology also facilitates collaboration, and engages the students in creating content in Web 2.0 applications [31] and much more.

In recent years, Web 2.0 technologies such as blogs, wikis, and social networking sites have been used to transform teaching and learning in higher education, given that such technologies offer software developers and end-users the ability to create and modify content online. These technologies facilitate the way in which students can share content compared to the past. Additionally, such technologies have an influence on the way documents are created, used and shared with others [32]. Through the use of Web 2.0 technologies including social networks, the role of students is becoming more about creating content than merely consuming information and knowledge [33]. Students also become producers and consumers in their own education by using Web 2.0 and social networks [27].

It would seem that as students engage with Web 2.0 applications in their daily lives, new fruitful opportunities are emerging in the domain of the educational environment [34]. Although these applications are not designed for educational purposes, they do have numerous affordances that can bring benefits to learning [35]. The blooming of Web 2.0 is opening the door for new practices and attitudes in the learning domain [33], and also improving students' learning experience and writing ability [36].

For these reasons, the current research combines a Web 2.0 approach with educational activities.

2.3 Mobile Technology: Benefits and Challenges for Learning

Up until now, and even with the massive advances in technology, students in education still use traditional pen and paper for learning activities such as note taking [3]. However, traditional pen and paper has no advantage due to its lack of efficiency for such learning activities, thus rendering itself unappealing to students ([37][38]). In fact, the efficiency and effectiveness of learning activities can be significantly augmented with the use of mobile technology for learning [39]. Mobile technology has offered a new educational approach that enables students to access the content of the material, or any other information related to the course, on the go whenever they are located ([40][41]).

In recent years, the rapid growth of mobile technologies is promising a new revolution that might be comparable with that of the web [42]. In the education sector, mobile technology has increasingly been used in learning and teaching in higher education. Mobile technologies in education can help in supporting teaching and learning, such as affecting personal organization without explicitly being part of the learning activity themselves [39]. According to Traxler [41], using wireless, mobile and handheld devices has gradually increased, and this use has been disseminated across educational sectors. Moreover, mobile devices are ubiquitous amongst student populations in universities [38].

Mobile learning (m-learning) may be considered as a learning tool for accessing content, which can be locally stored on the device or can be reached through interconnection [42]. The most obvious use of mobile devices for educational purposes is in fact a direct application of e-learning techniques on smaller devices instead of those on a desktop PC [42]. Other research indicates additional benefits related to mobile learning. Mobile technologies are convenient to students, as they offer a relaxed fit, a simple, small size device, flexibility, ease of movement [43] and less printing papers [58]. They also provide

mobility, content review, enhanced communication, and support interactive and collaborative learning [44].

Recently, rapid advances in mobile learning have been viewed as a major trend in higher education. Georgiev et al. [45] pointed out that m-learning offers a new way of learning and teaching which redresses the deficiencies of traditional education. Indeed, Georgiev et al. [45] have highlighted the fact that m-learning is becoming a new form of learning worldwide that is based on mobile devices such as the PDA, cell phone and Tablet PC. According to Herrington et al. [38] and Sharples [11], the use of mobile devices has already grown amongst students as well as across all educational areas. Sharples et al. [47] argued that handheld computers and mobile communication are technologies that can be used in supporting individuals to learn anytime, anywhere. Similarly, Naismith et al. [39] have claimed that mobile devices and personal digital assistants are the most prevalent technologies for mobile learning. Moreover, Traxler [41] emphasises the fact that mobile learning has been growing obviously and significantly in higher education. Alexander [48] has stated that students learn more effectively with mobile devices than they do with desktop computers. According to Evans [49], using m-learning as a teaching and learning strategy for college students appears to be an effective tool in higher education. Another study by Fozdar and Kumar [50] has indicated that using m-learning could help to improve student retention by enhancing the delivery of education. Traxler [51] highlighted the fact that m-learning is a new educational format. Scornavacca et al. [90] also found that for handling questions in a large classroom, traditional text messages on the mobile devices can be used as a more practical and efficient way than the traditional raising-hand method. Hence, this strongly suggests that m-learning is an innovative educational tool, since many researchers attempted to investigate how these mobile technologies can be employed for educational activities.

The rise of m-learning could well be due to the fact that mobile devices are ubiquitous amongst student populations in universities [38]. Indeed, mobile devices perform many of the functions of desktop computers with the advantage of simplicity, in that they are 'easy to carry' and give improved access anywhere, anytime [52]. The widespread ownership of mobile devices and the availability of other portable and wireless devices have been the landscape of technology-supported learning ([148][53]). These technologies turn out to be well aligned with strategic educational goals such as improving student retention [54].

On the basis of the aforementioned discussion, we can easily argue that mobile technology has reshaped the way we learn in the classroom. Hence, the current thesis takes the mobile approach to enhance the student experience in note taking.

2.4 Shift from Web 1.0 to Web 2.0: Emerging Technologies for Learning

Web 1.0 is a read-only web [60] which can be described by Aghaei [61] as a "Web of information connection". Web 1.0 has been accessed in classrooms as a repository of information and the students in Web 1.0 can be viewed as information recipients rather than as producers of knowledge [23]. The main goal of web pages on the Internet in the age of Web 1.0 was to publish information for people at any time and in one direction only [62]. However, Web has been transformed and improved over time in order to allow two-way communication where users can consume and produce knowledge- the so-called Web 2.0.

Web 2.0 is the second generation of the World Wide Web [63]. The concept was first introduced by O'Reilly [64] who coined this concept in a conference brainstorming session in 2004 which was hosted by O'Reilly and Media Live International. Web 2.0 is diversely referred to as "read/write Web" [65], "wisdom web" [63], "social web", "modern web",

and/or “social software” [7]. Web 2.0 features and capabilities can be highlighted as follows [63]:

- Provides a rich user interface;
- Facilitates collaborative content creation and modification;
- Establishes social networks of people with common interests;
- Supports collaboration.

To summarise the difference between Web 1.0 and Web 2.0 in simple terms, one can argue that Web 1.0 Internet users can merely find and retrieve information online, but with Web 2.0, users can do much more in terms of creating and uploading content [60].

In the education sector, it seems that Web 2.0 technologies are significant in the domain of learning, given that such technologies are popular across students’ everyday lives [33]. Kaplan and Haenlein [67] stated that Web 2.0 represents the foundation for User Generated Content (UGC). Web 2.0 combines multiple features such as the dissemination of multimedia content, socializing and blogging [175]. One of the main ideas behind Web 2.0 is that it allows the individual to produce and generate content, and this seems to be very significant from a learning perspective. Thus, Web 2.0 has been widely used in the education sector for a number of reasons: ease of use, readiness availability, individual affordances and network effects [68]. According to Alexander et al. [68], two essential features differentiate Web 2.0 from other Web sites: micro-content and social media. The micro-content feature refers to the format of information generated on Web 2.0. This feature enables users to create small chunks of content, where each chunk reflects a main idea. Indeed, Web 2.0 was created to enable users to share small chunks of information between different users who share the same interests [68]. Accordingly, and given that Web 2.0 is mainly focused on content, it is increasingly becoming more and more attractive in the education sector in terms of making the process of learning more effective. On the other hand, social media as the second distinctive feature of Web 2.0

refers to the fact that Web 2.0 is more organised around people compared to Web 1.0. Web 2.0 makes creating and sharing content as well as interacting with other people readily possible, compared to the static web or so-called Web 1.0 [33].

In the education sector, Web 2.0 refers to a group of powerful tools that are being used in classrooms [65]. These tools include, but are not limited to, blogs, wikis, Really Simple Syndication (RSS), podcasting, and social networking sites which are growing rapidly in education [34]. Wikis are a collection of web pages designed to enable users to add or edit the content. They are mainly used for easy collaboration amongst many individuals and thus it is usually utilised to build collaborative websites [69]. According to Conole et al. [70], wikis are considered to be an ideal tool for facilitating cooperative learning. On the other hand, Blogs refer to personal publishing spaces and this concept was derived from a personal home page. They have been labelled as reflective diaries, as they emphasise the personal reflective parts of sharing ideas [70]. Bloggers formerly used to write blogs on their personal web pages. However, nowadays, most bloggers use social networking sites such as Facebook to write their blogs or viewpoints. Accordingly, blogging as a practice has been relocated from a private and personal space to a shared, collaborative space [70]. Moreover, podcasts also seem to be useful for learning. In fact, podcasts are digital media files, usually video or audio, that are available for free download from the Internet, or through a subscription model.

The literature indicates that the use of Web 2.0 technologies will positively influence students' learning and make it more effective [147]. There are some examples in the literature that highlight the positive influence that Web 2.0 technologies have on learning. Uzunboylu et al. [5] argued that the integration of Web 2.0 tools with the virtual learning environment revealed that using such tools with all activities in traditional classrooms can support students in better understanding the course, and thus make students' learning more effective. Another example is related to a study that was conducted by Bennett et al. [33] which highlighted the potential advantages of using Web 2.0 tools that allow students

to create content on social networks and share materials such as images, video and audio with their colleagues. Another study by Churchill [72] indicated that blogging facilitates learning for undergraduate students. The activities that were observed during that study with students focused on accessing the materials of the course, posting reflections, featuring artefacts created through the learning tasks, commenting on each other's contributions and otherwise participating on a regular basis throughout the experiment period. The students in this study reported with agreement that integrating blogging with their learning activities facilitates and encourages them in their learning. Focusing on wikis, another study conducted by Wang and Turner [73] found them to be more useful and effective for enhancing learning in classrooms. The study indicated that the original wiki is usable in the education environment, but pointed out that it only accepts one update where two students try to update simultaneously. The wiki extension that was developed aimed to allow course content to be created and updated collaboratively and simultaneously, which proved to be positive for learning. A study conducted by Chen et al. [179] has found that students felt significantly more satisfied with using blogs for note taking than students taking notes using a wiki. Moreover, according to Lockyer et al. [74], the potential for integrating Web 2.0 technology with education in postgraduate classes would support the formal educational experience, and result in a positive learning outcomes and experience. Apparently, and according to previous relevant literature, the use of Web 2.0 tools is advantageous, and has a positive impact on the learning process. Learning activities have become more interesting to students, and have enhanced their learning skills [75].

This discussion of the differences between Web 1.0 and Web 2.0 aims at highlighting how significantly the web has changed in a relatively small amount of time. This opens the window to assuming that the rapid development of the web and its supporting technology can play a deciding role in many disciplines including education. The approach presented

in this thesis focuses on the potential of the web and what it can offer for students in the domain of note taking activities.

2.4.1. Social Networks and Learning Activities

Social networking sites have been defined by Boyd and Ellison [76, p.211] as “web-based services that allow individuals to (1) construct a public or semi-public profile within a bounded system, (2) articulate a list of other users with whom they share a connection, and (3) view and traverse their list of connections and those made by others within the system”. Users on social networking sites such as Facebook are allowed to post profile information to communicate with others online in several ways, such as sending either a public or private message or sharing photos or videos [77]. According to the Pew Internet and American life project [78], 74% of American online adults were found to be users of social networking sites in 2014. The number of social network users worldwide in 2014 reached 1.87 billion, and it is estimated that the number of users in 2018 will reach 2.55 billion [79]. The Pew Internet survey reported that 70% of social networking site users are college students [80]. Accordingly, it seems there is no doubt that the number of users on social networking sites is significantly growing.

Social Network Sites have been used recently as a new trend in learning and teaching in higher education. Indeed, such sites have a huge potential to shape how people learn [81]. This is to be expected, given that most current students have grown up in the digital age where such technologies are heavily used in all areas of their lives including their learning and teaching activities. In fact, Twitter is one of the most popular platforms to have been employed recently in teaching and learning. For example, Dhir et al. [82] show that a significant growth in the popularity of Twitter is already present in the educational sector. According to Harris and Rea [84], Twitter is a combination of social networks and a micro-blog service that enables users to compose and read a message known as tweets in just 140 letters. Users on Twitter are limited to the use of a specific number of words

per post compared to Facebook. Twitter offers a faster way for collaboration and communication as the length of the post is short and brief [83].

Twitter is one of the most popular micro-blogging tools [83], with more than 41 million users as of July 2009 [85]. Junco et al. [87] found that Twitter has been used in teaching and learning amongst the students. Twitter has been deployed in a number of ways in higher education [88]. Recent evidence shows that Twitter has a significant impact on students' engagement in learning processes. To give just a few examples, it was found by Tyma [89] that one of the advantages of using Twitter in a classroom setting was that it offers students an additional channel for communication. This study reported that Twitter has been used in a large lecture, and suggested that Twitter provides a way to present and share ideas and shape the discussion and that it is also a cost effective tool for engaging students. Junco et al. [87] argued that using Twitter changes the way traditional activities take place in classrooms and leads to keeping students engaged.

As reported by Kassens-Noor [91], Twitter as an active and informal tool for learning has benefits and challenges compared to traditional learning. Twitter facilitates sharing beyond the walls of the classroom, whilst it is a convenient tool for discussion amongst students that can be used at any time/anywhere. On the other hand, Kassens-Noor [91] has argued that the challenges of Twitter are related to the strict word limit and require the constraining of critical thinking and self-reflection. Further, a survey of faculty members, guests, and students on a pharmacy management course that was conducted by Fox et al. [92] showed that although 80% of the sample found that Twitter facilitates class participation, 71% and 69% of the sample respectively indicated that Twitter was distracting, and actually prevented note taking.

Accordingly, the literature shows inconsistent results regarding the appropriateness of using Twitter in classroom settings and for educational purposes. A plausible explanation for this is that Twitter and similar social networking sites, despite their potential

usefulness, are not specifically designed as an educational tool that supports the learning process. Therefore, a new application in this research was built for educational purpose such as note taking activities in classrooms.

2.5 Microblogging as a Learning Activity

Microblogging, also known as mini-blogging, is a Web 2.0 technology that has rapidly gained huge interest over the past decade [125]. Microblogging is defined as a Web2.0 technology and a new form of blogging that allows the users publish online brief text updates, usually less than 140-200 characters, sometimes images too [6]. Additionally, Ross et al. [128, p.4] describe Microblogging as "a variant of . . . blogging which allows users to quickly post short updates, providing an innovative communication method that can be seen as a hybrid of blogging, instant messaging, social networking, and status notifications." Ebner et al. [4], on the other hand, describe microblogging in the classroom as posted thoughts and information pieces.

Moreover, microblogging in education is considered to enhance the activities of the classroom learning experience [10] and facilitate informal learning [4]. In addition, microblogging is used as a form of mobile learning technology [176] and as a learning enhancement in university formal courses [177].

Furthermore, microblogging can be described based on the three key concepts of blogging: creating short text content, user's ownership of created content and the aggregation of the created content ([128][164]). In addition, Java et al. [83] state that there are three main microblogging activities: sharing information, seeking information and building friendship relationships. These microblogging activities are based on the unique feature of 140 characters [119].

As noted in a previous study by Ebner et al, [4], the successful use of microblogging for students in education results in a number of benefits. For example, some of these benefits

include obtaining informal learning through informal communication, collaboration support, and the ability to reflect on one's own thoughts. These and other benefits show that there is great potential for using microblogging in education.

One of the most popular micro-blogging tools is Twitter, with more than 310 million users as of the first quarter of 2016 [165]. In addition, about a third of Twitter users in the UK are under the age of 25 [86].

Twitter has been deployed in a number of ways in higher education [88]. For example a study by Tyma [89] used Twitter in a classroom setting as an additional channel for communication. Also, Ebner et al. [4] studied microblogging as an informal learning tool for communication, and found that it supports the information flow between students in the classroom and also with teachers.

However, a survey of faculty members, guests, and students on a pharmacy management course that was conducted by Fox et al. [92] showed that although 80% of the sample found that Twitter facilitates class participation, 71% and 69% of the sample indicated that Twitter was distracting, and actually prevented note taking, respectively. Hence, technology in general is sometimes distracting in class [93].

Furthermore, a study conducted by Hus et al. [119] sought to explore how best to enhance learning in an online undergraduate course in meaningful contexts. The course used in this study requested that students use Twitter on their mobile devices to collect, share and comments on authentic design examples found in their lives. The results generated from this study indicate that students had a positive perspective towards mobile microblogging activities for learning. The study also investigated the value of microblogging to enhance learning in online course in authentic contexts.

A real live setting experiment was carried out using microblogging to track students' usage in the course and outside the classroom. Moreover, the aim of the study was to answer

the students' questions, and the authors concluded that the use of microblogging is substantial in learning and provides facilitates beyond the class [4].

Holotescu and Grosseck [6] designed a microblogging platform especially for education, known as Cirip. The platform aimed to deliver online courses in the form of video/live/audio messages and offered facilities such as collaborative groups and monitor feeds. On this platform, users were able to write notes privately, create private groups and public groups, embed any multimedia resources like image, video and document in notes, subscribe and search feeds provided by slides, social network and web for both users and groups. This study provided outcomes of mobile learning through microblogging for such activities like posting notes and sharing materials in online courses and virtual space.

It may be concluded that there is a great deal of potential for the use of microblogging technology for learning. A number of the studies mentioned above discussed ways in which this technology has contributed to valuable outcomes across various activities in education, including promoting learning and ultimately achieving a positive experience for students. Although a large amount of research has explored the usage of microblogging in different fields, there is still a need for further research to improve the usage of microblogging in learning and teaching [4]. Hence, the work in this thesis integrates microblogging with note taking activities to enhance students' note taking experience.

2.6 Note Taking as Learning Activities

The rich body of research conducted surrounding the practice of note taking has concerned itself with the functions of note taking in learning, why students take notes in class, how they take the notes and what the issues of note taking are. This section aims to review the activity of note taking and its importance to students, as well as to touch on the

challenges attached to this activity that have motivated this research, as introduced earlier in the opening of this thesis. It further explores the tools and applications for note taking activity.

2.6.1. Note Taking Functions and Purposes

Note taking activity is popular across most students at different levels of education, which reflects its importance [97]. It is an essential skill for transmitting and archiving any information for studying in all courses [98].

Di Vesta and Gray [99] classified the note taking activity function into two categories: the process known as encoding and also the product known as external storage. Encoding records the presented information for long term use [99], whereas external storage is the construction of a stable memory to store the notes captured in a format that can be used later [99]. According to Hartley et al. [97], students hold the belief that note taking serves both these functions: process and product.

Numerous purposes for note taking have been highlighted in the literature. Beginning with Di Vesta and Gray [99] the process of note taking as encoding helps students to maintain attention and transfer the knowledge delivered in the lectures to long term memory. The product of note taking thus serves as external storage for what was noted in the lectures for later review. Boch et al. [100] add that note taking seems to ease the load on working memory. Indeed, note taking was highlighted by Bonner and Holliday [101] as a useful tool for students to note down information in class rather than depend on their memories.

Furthermore, Carrier et al. [102] stated that note taking is used to increase the retention of information. Similarly, Van Meter et al. [103] showed that the aims of note taking are learning and organising the materials presented in the class, and the notes themselves are to be used later for doing homework and studying for exams. Boch et al. [100] confirmed that the aim of note taking is to create external storage for the notes, reordered in a form that can be recalled and used later.

It would therefore seem that students take notes for a number of reasons. Hartley et al. [1] reported that there are two reasons generated through subjective feedback and objective feedback: one is the process of information delivered in the lecture, and the other relates to recalling the product of the notes themselves later. From the point of view of the respondents, note taking itself helps to maintain attention, understand the material structure and subsequently recall it. Furthermore, most of the respondents believe that the product of their notes will be useful for later review. Similarly, Boch and Piolat [100] demonstrated that students take notes for two main functions: to record information in class or/and aid reflection. Certainly, Badger et al. [104] suggested that the aim of note taking is to recall as much as possible from lectures, and argued that taking notes may help to achieve this either because the process of taking notes aids concentration or because the product of the notes facilitates some kind of a recalling process.

In addition, the significance of note taking has been summarised by Karimi [105] as follows: useful for review, helps to focus on the subject, helps to remember, a way to organise ideas, facilitates the selection of important notes, helps understanding, an approach to learn, create and think, serves as external memory, makes students active, and extends the span of attention.

Research has indicated the importance of notes themselves in students' learning. The outcomes from the comparison between different types of notes for review made by Kiewra et al. [106] confirm the recalling of the three different kinds of notes: a complete text, a liner outline or matrix contributes positively to improving the students' achievements. In the study conducted by Kiewra et al. [107] students who took notes performed better in the exam than those who did not do so. Similarly, the findings from a previous study conducted by Kiewra [108] showed the importance of recording the notes from the presented information during lectures, and how this resulted in a positive impact on the students' scores. Kiewra [109] further reached the conclusion that there is a positive connection between the process of note taking and review in relation to the students' learning. Cater et al. [110] indicated that the goal of student note taking is not

just in taking them, but also in having them to review later. Ward et al. [111], meanwhile, highlighted the fact that note taking is not just an approach for recording content. Other investigators have stated that note taking is not just notes recorded by students in their own words; these notes have been found to be useful for reviewing content and to aid in improving their examination grades [112]. This research focuses on recording the notes; in other words, capturing the notes in classrooms.

2.6.2. Note Taking Issues

Students play a role across note taking activity as recipients of knowledge [104]. Students in class take notes while attending a presentation [109] or while listening to a lecture [1]. Note taking has been widely used in students' learning throughout all levels of education particularly lectures [14] . When taking notes, the majority of students intend to capture what the teacher presents or explains during the lecture [97]. Similarly, other investigators have found that some students copied what was presented in the lecture or summaries [98]. The main aim of note taking in learning is to record briefly the main ideas [107].

However, these notes could either include specific details, or may simply record the important points. In many cases, students return frequently to the lecture handout or online lecture notes. Certainly, these materials are valuable resources for students; thus, it is important to note that they often do not include all the important points that the teacher stated or mentioned during the lecture.

Although note taking is clearly an important activity for learning, students frequently fail to capture the important ideas in their notes. The note taking practice of students using traditional approaches is still considered poor and inefficient [38]. When it comes to note taking, many student behaviours can be observed. Students' notes are limited, with a relatively small percentage recording 35% of the delivered materials [114]. Students are bad note takers, recording merely half of the critical ideas in a lecture [115]. According to Kiewra [109] the students' notes are generally incomplete and inaccurate, recording a limited amount of the critical ideas presented in the classroom. Kiewra [108] stated that

note taking may seem ineffective due to the often incomplete style of college students' note taking. Also Austin et al. [16] argued that students are generally poor note takers in recording the main points. Barnett [114] highlighted that students' notes must be complete to serve effectively their external storage. Katayama et al. [116] argue that reviewing these notes resulted in missing out the benefits of external storage, as they were reviewing incomplete notes later.

Given these facts as regards students' note taking behaviour, a great many different ways have been explored to support students' note taking. Providing students with cues as to when to take notes or not in class significantly improved their performance in the test question taken from the material presented with this cueing technique [117]. Locke [118] found that students record most of the material written on the board, only missing 12% in contrast to material presented verbally. With Austin et al. [16] students take notes across different lecture formats to assess their note taking behaviour improvement as regards critical points. In a traditional lecture, students included an average of 62%, in the slide lecture students included an average of 97% and with the slide plus guided notes students recorded an average of 100%. These numbers are the results of the notes that students recorded on different lecture formats. Austin et al. [16] found that the traditional approach to a lecture falls short of other lecture formats with respect to enhancing note taking behaviour. This is an indication that the traditional way of learning in class involves so many challenges that it may not be appropriate for such updating. Dezure et al. [14] argued that the reason for bad note taking behaviour might be a lack of essential note-taking skills, or may relate to the complexity of the material presented. They suggest that strategies for engaging students to support their note taking can improve their note taking experience.

As touched on above, note taking is one of the important learning strategies in education. It helps students to note down the information delivered in the lectures, and also contributes to increasing their performance in the exam. Therefore, it was imperative in the current research to bring in a new approach to support this crucial practice in class.

The journey began by looking for a new technology from the new trends in education to be implemented and evaluated in this thesis; which aims to investigate the experience of students.

2.6.3. Previous Studies on Note Taking Technology

Studies focused on the tools and applications designed to support note taking using new trends of technologies in education are highlighted. Existing technological note taking approaches proposed by other researchers were reviewed to explore what has been previously done in the literature as follows.

E-notes: these were developed by Wirth [180] to provide students with electronic lecture notes that can be printed as a hand out or annotated during the lectures. The evaluation results showed that e-notes help students to concentrate on the material, as well as engage in other class activities such as discussion. Subjective and objective feedback indicated that students found e-notes to be a valuable application to use for note taking. E-notes aided the students in concentrating on understanding the materials. They also made the lecture notes available electronically before the class.

Collaborative note taking: was developed by Singh et al. [57], enabling students to take notes on their PDAs and share them with their study group. The data collected and the feedback from students indicated that reusing the words from other available resources either slides or fellow note-takers in real time was useful. Students can use text from the slides and from other students to construct their notes. This system improves the speed of entering text and awareness between the members of the study group (see Figure 2-1). Therefore the solution of using short text feature and enabling the learners to generate their own content rather than reusing input already entered might be advantageous. Thus I concluded that further research was needed to investigate the use of short feature of micro-blogging to support learners' note taking activity.

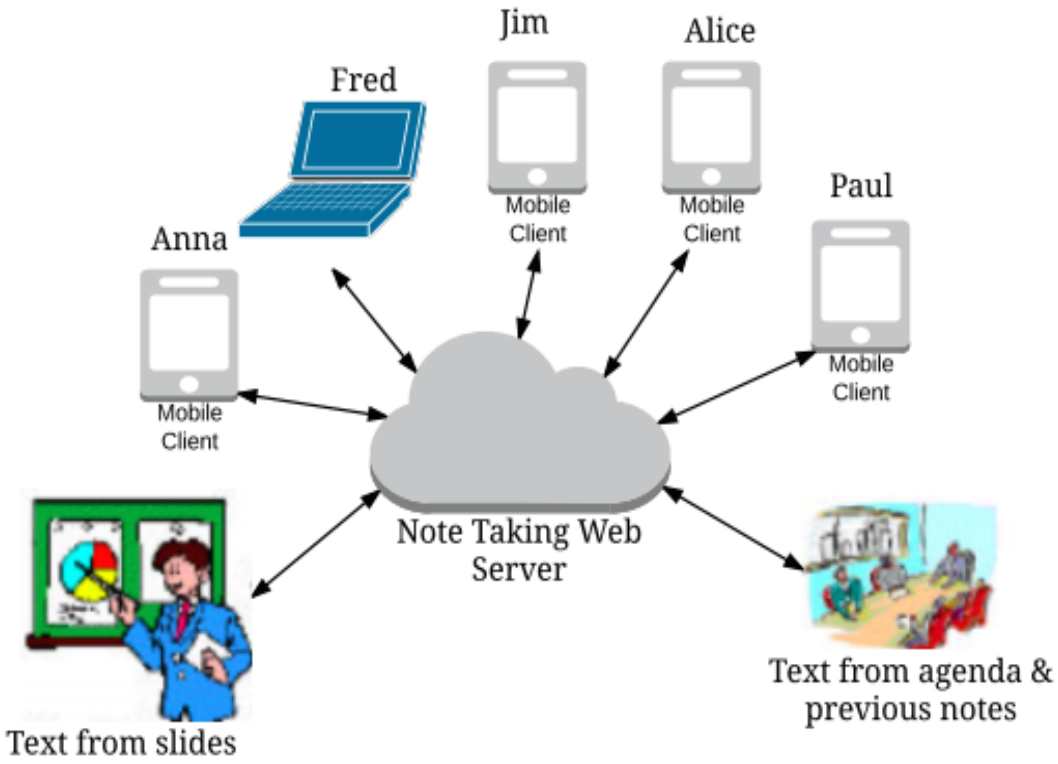


Figure 2-1: Collaborative note taking (Singh et al. [57], redrawing)

StuPad was developed by Truong and Abowd [66], and integrates different steams of information such as notes, audio and video. StuPad integrates information generated by individual students and information presented by the teacher in the lecture. It is designed based on two interfaces, one for capturing and the other one for accessing and reviewing. Students are offered two different streams for taking notes: one is private on their notebook, and the other is for annotating their copy of the lectures' notes. StuPad also supports a pen-based interface for note taking. It has a simple interface to use (see Figure 2-2). However, Stupad did not investigate the short text for typing the notes.

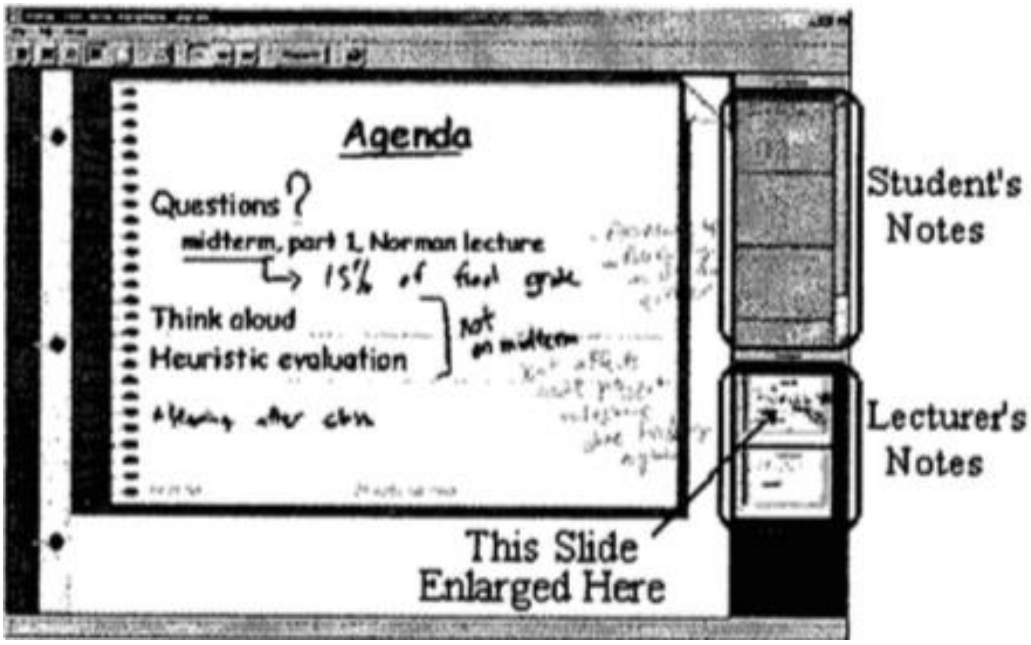


Figure 2-2: StuPad (Truong and Abowd [66])

Note taker was proposed by Ward [111] to take notes in class. It was designed using a number of computer features in order to adapt note taking activity. These features are a pen for drawing, text decoration from the keyboard, text positioning and keyboard for text input. The evaluation of Note taker shows the other features required to support the task of taking notes using the computer such as graphics and text and time (included), as shown in Figure. 2-3. However, this approach did not tackle the feature of short text for note taking like the current research does.

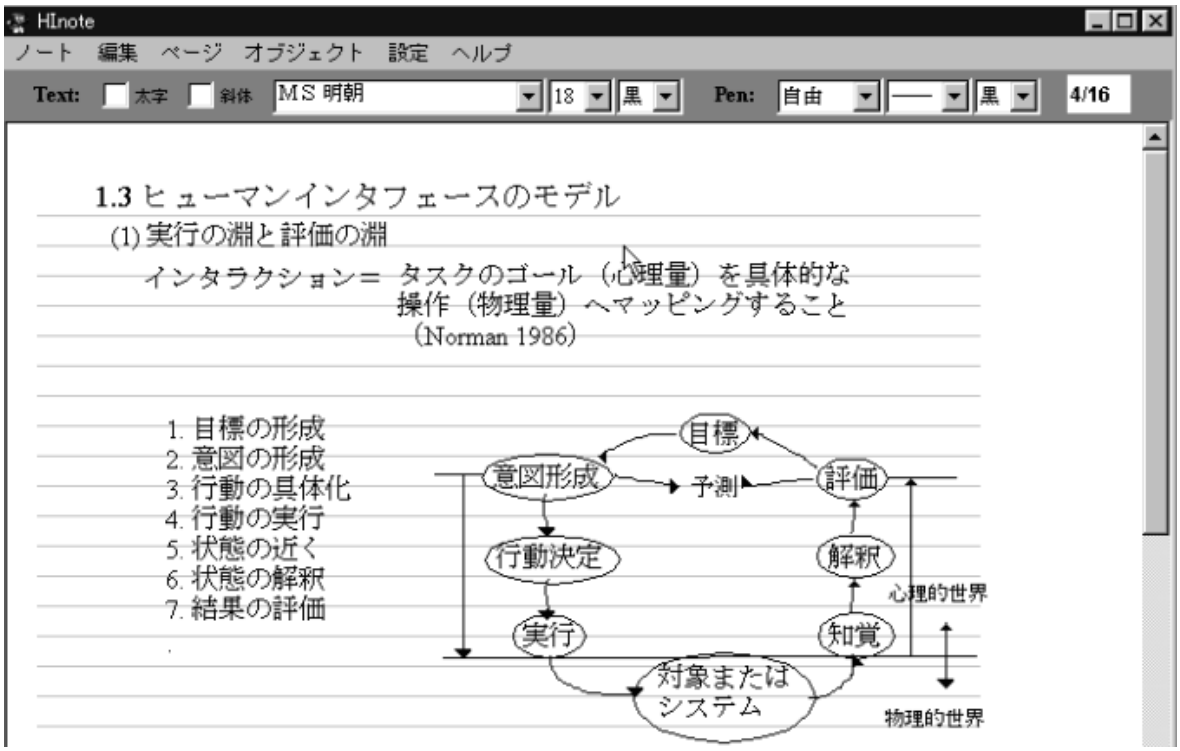


Figure 2-3: Note taker (Ward [111])

Livenotes was described by Kam et al. [152] as a means to take notes in small groups in lectures, using a whiteboard and Tablets. The first feature is that the system allows students in the classroom to take notes cooperatively. The second feature is the capability to annotate over the lecture slides that were provided to expand students' note taking. The evaluation results show that the Livenotes system supports cooperative note taking, as well as engagement in discussion in small groups (see Figure2-4). This system focused on cooperative note taking rather than the short and fast form of notes captured during the lecture. This study did not investigate the use of short text feature of micro-blogging for note taking, as in my research.

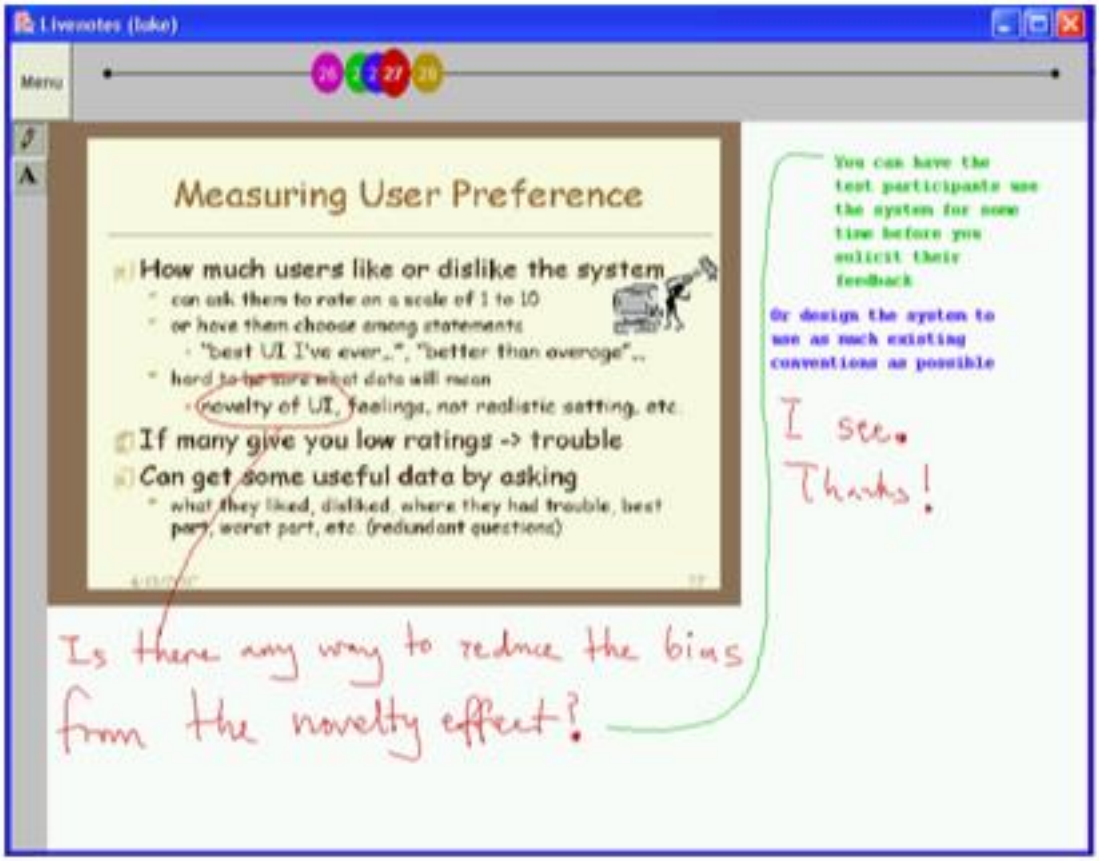


Figure 2-4: Livenotes (Kam et al.[152])

DyKnow was designed by Berque [150] to be used by students and teachers for managing interactive classroom activities. Students are able to take notes, annotate, receive the content used in lectures, print their notes and access their notes in the stored server. The teacher can comment on the collected students' work or mark the quizzes and return it electronically via DyKnow to the students. The evaluation results showed that students felt the system had a positive impact on what they learned in computer science. The results also demonstrated that the faculty members also found value in using DyKnow. This study indicated that there is a rapid change in the nature of text input, according to the students' need. However, the text input investigated in this study is not the most popular text input, namely the short text feature of microblogging for note taking, which I further investigate.

Groupnotes was developed by Reilly and Shan [56] to increase the engagement in the classroom. The small group of students can participate in a real time lecture to take the notes collaboratively on their own smartphones. The aim of this work was to provide students with an interface for note taking that has such features as: synchronisation of multi users' editable notes and longer smartphone battery life via compression of operation buffers (see Figure 2-5). It focused on how the degree of engagement can be increased across a small group of students while note taking using their own smartphones. This study, however, did not investigate the short text for note taking either, as in my research.

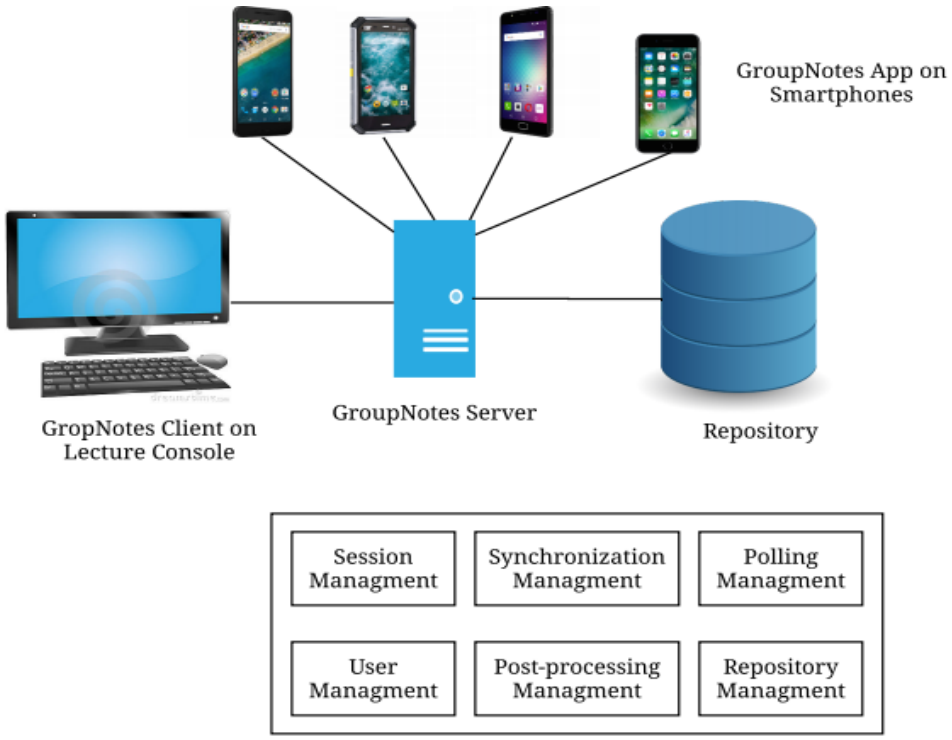


Figure 2-5: Groupnotes (Reilly and Shan [56], redrawing)

Shared text input technique: this was developed by Denoue et al. [55] to facilitate shared text input on small devices for note taking. This system was developed for sharing notes by reusing the words and phrases already entered by users, instead of writing the words on the small screens of these devices. This system allowed the user to reuse the text entered by another user. Other notes produced by others in class are available to access

and share after the class. The system provided more options to the users for sharing text extracted from other sources e.g. previous notes, agendas of meetings or abstracts. This study found that shared text input raised awareness among followers in note taking during lectures. Again, this work targeted the speed texting input for note taking on small screen by filtering the words and phrases on small screen, which are entered by others or extracted from different resources. This work did not apply the fast and short text feature of micro-blogging for note taking in class, as in my research.

NotePals was developed by Landay et al. [149] for sharing notes. It aimed to support group work so as to share the ideas and experience captured during a class or conference. It was implemented on a personal digital assistant which involved ink-based capture. The target in this work was to enhance the sharing of notes between the participants in group work after the class, as shown in Figure 2-6. This system focused on supporting collaborative work after class. This application did allow the creation of ink-based notes on the small screen with no specific length, or even by using the soft keyboard of the mobile device, which are further used in my research.

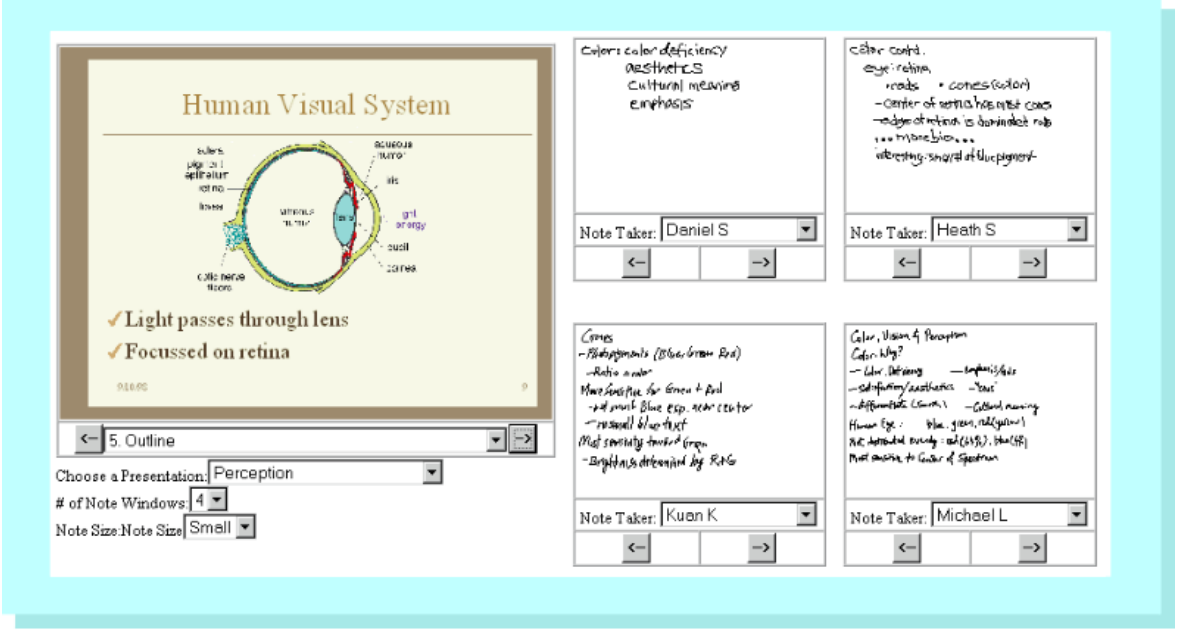


Figure 2-6: Notepals (Landay et al. [149])

ZenPad was developed by Abowd [151] to capture notes as one of the classroom experiences (see Figure 2-7 below). The figure shows an interface for lecture slides and teacher comments. It was concerned with capturing as much as possible of the classroom experience. The author described the classroom as a multimedia classroom session. One of the main objectives of this work was to produce multimedia content that supported students in terms of recall. This work has not addressed what kind of notes the students captured across the multimedia classroom. The students experience with the notes captured has not been investigated in this work.

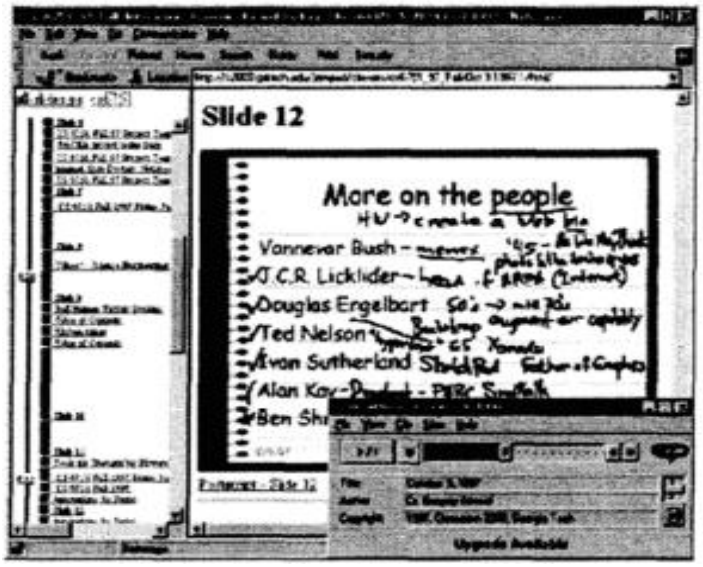


Figure 2-7: ZenPad (Abowd [151])

2.6.4. Review of Other Note Taking Apps in the Market

There has been much commercial software lunched on the market. For example: Evernote and OneNote are the most common software tools for note taking [46]. These applications are used to make lists, manage projects, store and organize information and share it with others [142][120]. Also, ColorNote which is one of the apps for Android users was reviewed [182].

Evernote and OneNote: these software tools are designed for general purposes. Evernote provides an advance tool for formatting text. Files, audio and video can be attached to the notes while other resources like images can also be attached. These images are located

either in the computer or taken using a snapshot with a webcam. Evernote is more focused on taking notes from the web [113]. This can be clearly noticed from its clipping web pages feature. OneNote, meanwhile, deals with text input using a basic word processor with rich options for editing. It provides features for adding other items like images, audio, video, PDF files or word files. OneNote essentially covers the storing and organizing of information [71]. It is more focused on taking notes in electronic pages. This can be clearly noticed from its notebook, which includes several pages and sections. These applications have been mentioned or used in the literature for note taking (e.g. [3][9][17]). EverNote and OneNote are also developed for Android and iPhone smartphones.

ColorNote: is a new simple Android application that is designed also for general purpose. The application allows the users to take notes on their mobile devices. The main feature of ColorNote is the ability to change the background colour of the notes. The application is designed to help users manage their notes. The notes can be sent by using other application (see Figure 2-8)

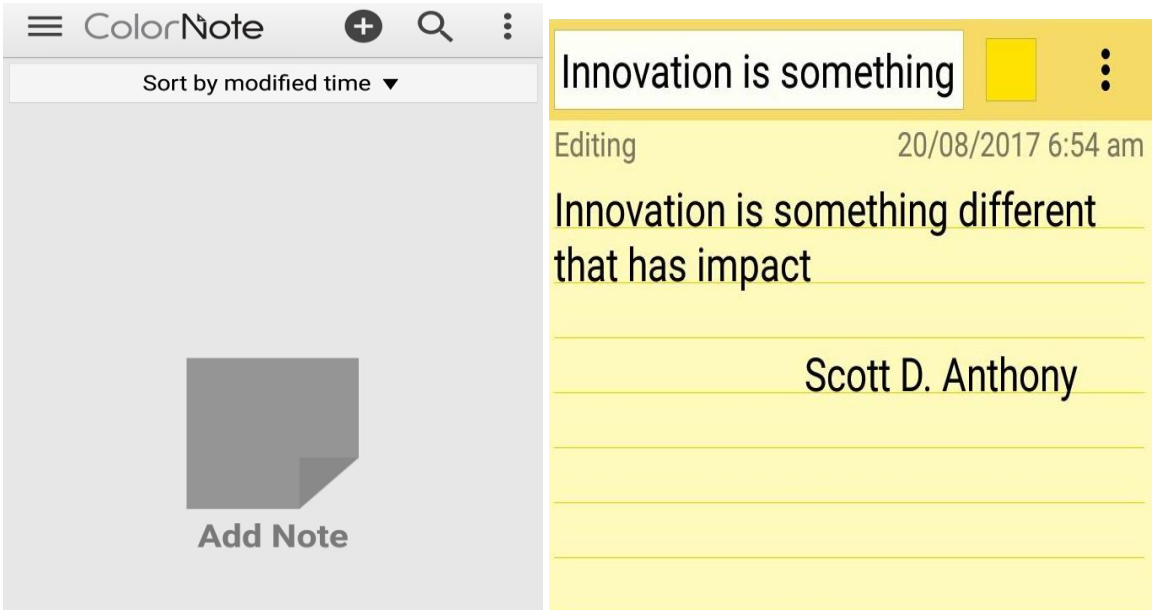


Figure 2-8: ColorNote (Hindy [182])

Apple pencil: one of the recent apps in App Store for note taking. It works especially with the availability of iPad pro and Apple pencil [59]. The application allows users to create multiple notebooks and various pages, and to draw and insert images. It is a modern style of traditional note taking using pen and paper. However, this application requires ipad pro and Apple pencil to work, and students might be charged for it (see Figure 2-9).

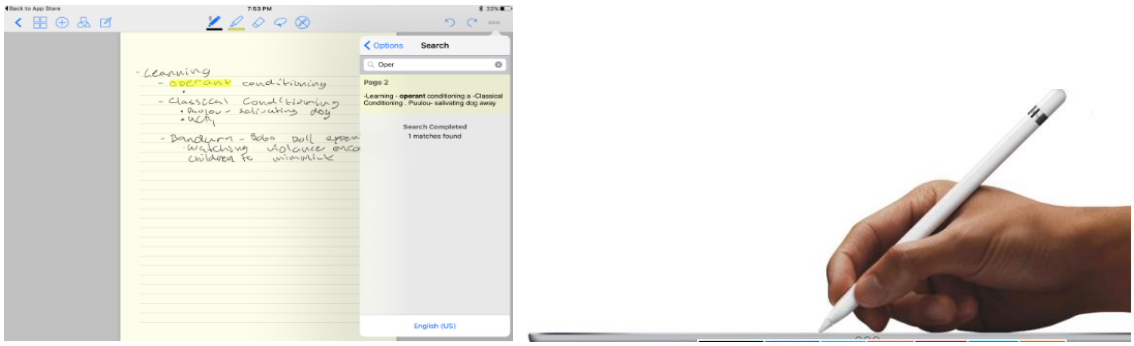


Figure 2-9: Apple pencil (Miller [59])

Table 2.1 shows a brief overview of the most common commercial mobile note taking applications. These apps were designed for desktop use at the beginning, but moved to mobile smartphones with the increasing usage of apps on smartphones. This has made commercial companies try to squeeze a lot of the note desktop application features into a small screen: the mobile device screen.

Table 2-1: Examples of common note taking apps' basic functions in the market

Features	Note Taking Apps			
	Evernote	OneNote	ColorNote	Apple pencil
Organize information	✔	✔	✔	✔
Store information	✔	✔	✔	✔
Attachment	✔	✔	✖	✔
Share information	✔	✔	✔	✖
Search information	✔	✔	✔	✔
Sync information	✔	✔	✔	✔
Short text	✖	✖	✖	✖
Mobile application	✔	✔	✔	✖

Most of the research regarding note taking using technologies was conducted by targeting shared note taking and collaboration. Although fast text input entry for note taking has been investigated extensively through the literature, there are only a relatively small number of studies that have integrated and tested the short text feature of micro-blogging in mobile note taking in class, in order to support the students' note taking experience.

The utilisation of the features of micro-blogging for note taking reasons is particularly important now, given that current students have grown up in the digital age, where technology is present in all areas of their lives, up to and including learning and teaching. Indeed, Ornstein [98] claimed that age is one of the features that should be considered to support students' note taking activity, as there is no one method for note taking that is better than any other. Therefore, it is necessary to propose a novel innovative application for note taking activity in higher education, taking into account the younger generations, used to mobile applications and short text (microblogging), as well as further evaluating Ornstein's claim.

2.7 Existing Gaps in the Literature

This chapter aims to review the relevant literature to develop a solid theoretical background knowledge that would work as a cornerstone for this research. The studies discussed above have inspired the work in this research and have helped to address the specific research problem of this research as outlined in Chapter 1. The gap identified in the existing literature can be highlighted as follows.

- Although mobile phones are popular, there is still a shortage of solutions for deploying microblogging technology into note taking within mobile application to support students' note taking experience in a classroom environment.
- Research on note taking activities also focuses on supporting students' note taking in lectures by deploying a variety of approaches. However, there has been no attempt to

investigate the students' experience using mobile note taking through a microblogging technology in a classroom environment.

- Most of the research on using mobile technology for note taking activities in classrooms focused on sharing and collaboration between students, but not on the capturing of notes.
- There are different general mobile applications in the market for note taking. However, limited research has investigated their impact on note taking in the classroom.
- The use of microblogging for note taking activity as a mobile application in the classroom has not been properly explored.
- Most microblogging research has dealt with a variety of learning activities in class and beyond. No special attention has been given to the factors and features that influence the students' experience of note taking using mobile and microblogging technologies.
- Despite the fact that mobile and Web 2.0 technologies provide vast benefits to students in education, there is a lack of understanding in regards to features that can shape students' experience for note taking.
- Students still use traditional tools (i.e. pen and paper) for note taking, and do not use modern technology educational tools for writing down notes during lectures. This approach generates incomplete and inaccurate notes that affect the students' note taking experience.

2.8 Discussion

The literature review has shown that note taking is one of the most important activities used in learning, and has proved its positive impact on students' achievement. In addition, it has identified note taking as one of the most commonly used techniques by students during lectures. Traditionally, the action of capturing notes is conducted manually using pen and paper. However, it still seems that students' notes are incomplete and inaccurate [109].

In recent years, the rapid growth of mobile technologies is promising a new revolution that might be comparable with that of the web. Mobile technologies in education can help in supporting teaching and learning, such as personal organisation without explicitly being part of the learning activity themselves. M-learning can be considered as a learning tool for accessing content, which can be locally stored on the device or can be reached through interconnection. The most obvious use of mobile devices for educational purposes is in fact a direct application of e-learning techniques on smaller devices instead of those on desktop PCs.

Furthermore, Web 2.0 exploited many domains including education. In recent years, Web 2.0 technologies such as blogs, wikis, and social networking platforms have been used to transform teaching and learning in higher education. Additionally, Web 2.0 technologies have been used in a number of educational activities (e.g. communications and discussions) that are carried out by students in classroom settings. These activities appear to be more interesting and appealing to students when they are enabled by Web 2.0, which has the potential to enhance students' learning skills [119].

Most of the literature regarding note taking using technologies was focused on the features of student collaboration and sharing notes. Although text input entry for note taking has been investigated extensively through the literature, there are relatively few studies to have explored the use of microblogging in mobile note taking in the classroom. Moreover, none have investigated students' perspectives towards using microblogging in mobile note taking.

On the other hand, there are other note taking apps in the market that use Web 2.0 technologies. These applications have been mainly designed to be used on desktops (PCs), but they have moved recently to be available on smartphone. This has forced the developers of these PC applications to squeeze most of the features into a smaller mobile device (i.e. smartphone), which may not be appropriate for the small screen.

It seems clear from reviewing the literature that previous researchers have focused on some features that support the note taking activity. These features mostly focus on note sharing, collaboration and engagement. However, there has not been a lot of attention given to the “capturing” using advanced technologies, such as mobile and Web 2.0. Moreover, microblogging as a successful method of short content creation, has not been properly utilised in note taking within the classroom. Therefore, it can be concluded that note taking through Web 2.0 technology using microblogging in a new mobile application is worth investigating.

2.9 Summary

This chapter has reviewed the previous research in four main interrelated domains: note taking activity in the learning process, mobile technology, Web 2.0 technology, and microblogging technology. Moreover, this chapter has aimed to explore the field of note taking practices in the classroom in order to understand the current issues in note taking activity. In addition, a review has been conducted in relation to technologies for note taking activities in the classroom through extensive research on the theoretical background and related research.

Chapter 3

3 Investigative Study about Current Students' Note Taking

3.1 Introduction

In the previous chapter, the literature review provided insights into note taking as a learning activity. In addition, it highlighted the rapid advancement of technology in note taking in the classroom. It was shown that the traditional pen and paper approach is still dominant as a note taking activity in the classroom. This is despite students' attachment to mobile devices (e.g. mobile phones). Moreover, the review highlighted that Web 2.0 technology offered many capabilities for education that may support note taking activity and therefore can lead to a positive learning experience.

However, in the light of the literature no special attention was given to utilising some Web 2.0 technologies such as microblogging. Moreover, the review showed that microblogging as a mobile note taking application has not been investigated in the classroom as a note taking approach. The next step to be undertaken is to investigate the current note taking activities which relate to current students' note taking, as well as the possibility of integrating Web 2.0 technology into mobile application to support these activities.

This chapter introduces the second part of the investigative study phase. This consists of a survey approach and an analysis to present the findings. Finally, a discussion is made to draw conclusions.

3.2 Investigative Study Research Method

The investigative study is the second part of the first phase of the research design adopted throughout this thesis. It aimed to contribute to answering the main research question by addressing objective **OB2,** and therefore answering **RQ1**. It was also particularly important to pave the way for the later phase of the research.

Following the literature review discussed in Chapter Two as the first part of the investigation phase, the investigative study was conducted to explore current note taking activities in the classroom. In addition, the exploration aimed to understand students' perceptions of using Web 2.0 technologies. Therefore, an exploratory questionnaire survey was used for data collection.

However, the investigation focused on exploring data rather than testing a hypothesis [174]. The investigative study targeted undergraduate students at the University of Warwick. The outcomes of the investigative study were intended to help to understand students' current note taking, as well as the possibility of utilising Web 2.0 technology for this activity.

3.2.1. Data Collection

3.2.1.1. Method

A survey was selected as the primary quantitative data collection method. This was achieved by using a questionnaire as a survey instrument [133]. A nominal scale was used in the questionnaire as a simple and straightforward approach [134]. It was used to label and categorise the quantitative data in this study. A Likert-scale was used in the questionnaire to obtain numerical data. The questionnaire used a scale ranging from 1= not important to 5=very important illustrated in Table 3-1. Additionally, descriptive statistics (frequencies) were used to analyse and present the quantitative results from the investigation study [122].

Table 3-1: Likert scale used in the investigative questionnaire

Scale	Description
5	Very important
4	Important
3	Neutral
2	Not very important
1	Not important

3.2.1.2. Respondents

The respondents for this study were randomly chosen, based on the availability and accessibility of undergraduate students in the University of Warwick. Moreover, two lecturers were able to give some time at the end of their lectures to allow students willing to participate in the study to complete the questionnaire. These studies were conducted in two different departments: the Computer Science Department and the Business School. Therefore, the background of the participants was mixed between two degree subjects.

The questionnaire was distributed among 300 undergraduate students, and the collected response from participants at the end of the conduct study was 254. Among the completed questionnaires, only 225 respondents were found to be usable for analysis. In addition, participation was voluntary and all ethical approvals were obtained prior to the study being conducted.

The questionnaire included a cover letter that outlined the research aim and important definitions relating to note taking. The participants were asked to provide their perception regarding note taking activities and Web 2.0 technologies.

The researcher adopted an approach to gather a large number of responses for this study, based on the Cohen et al. [122] recommendation that the larger the number of

responses, the better. Therefore, the number of responses gathered was the largest number that the researcher was able to obtain for the investigative study.

3.2.1.3. Questionnaire Design

The questionnaire was designed to collect students' opinions in order to explore the current note taking activities from a students' perspective. The questionnaire consisted of four sections, as illustrated in Table 3-2:

Table 3-2: Investigative questionnaire design

Questions	Sections
(Q1 – Q2) Demographic items	The first section was designed to collect the demographic information of the students in terms of age and gender.
(Q3 – Q14) Questions for general information about the use of current note taking	Twelve questions were developed to obtain information about students' current note taking strategies including existing note taking applications such as Evernote and OneNote. This section helps to explore the current note taking in class.
(Q15 – Q16) Perception of using Web 2.0 platforms for educational purposes	The third section dealt with the respondents' answers about using applications using Web 2.0 platforms during lectures such as Facebook and Twitter. This section helps to understand the role of Web 2.0 in class.
(Q17 – Q19) Future expectations for new a mobile note taking application	The fourth and last section included questions in regards to which features from Web 2.0 platforms students would prefer to use for a new mobile note taking application. This section helps by leading towards the design of a potential note taking approach.

The questionnaire was pre-tested by eight PhD students from the Department of Computer Science at the University of Warwick. The aim of the pre-test was to test the questionnaire in terms of wording and readability. Feedback and suggestions obtained were used to make the required changes in terms of wording and clarity of the questionnaire. The full questionnaire for the investigative study used is presented in Annex II.

3.2.2 Data Analysis

The four sections of the questionnaire were analysed using descriptive statistics (frequency). This included an examination of students' demographic information and current nota taking activities. In addition, descriptive statistics were used to investigate students' perception of using platforms based on Web 2.0 technologies in the classroom. Finally, future expectations from current note taking practices were analysed to provide insights to support new note taking developments. The current section presents a description of the results that were gathered from the questionnaire.

3.2.2.1. Demographic information

Figure 3-1 and Figure 3-2 show the general overview of the respondents' characteristics in terms of their demographic information. According to the analysis, 93% of respondents were between 18 and 21 years of age, and 7% ranged between 22 and 25 years. In addition, 66% of respondents were males and 34% were females. All the respondents were in their first year at undergraduate level.

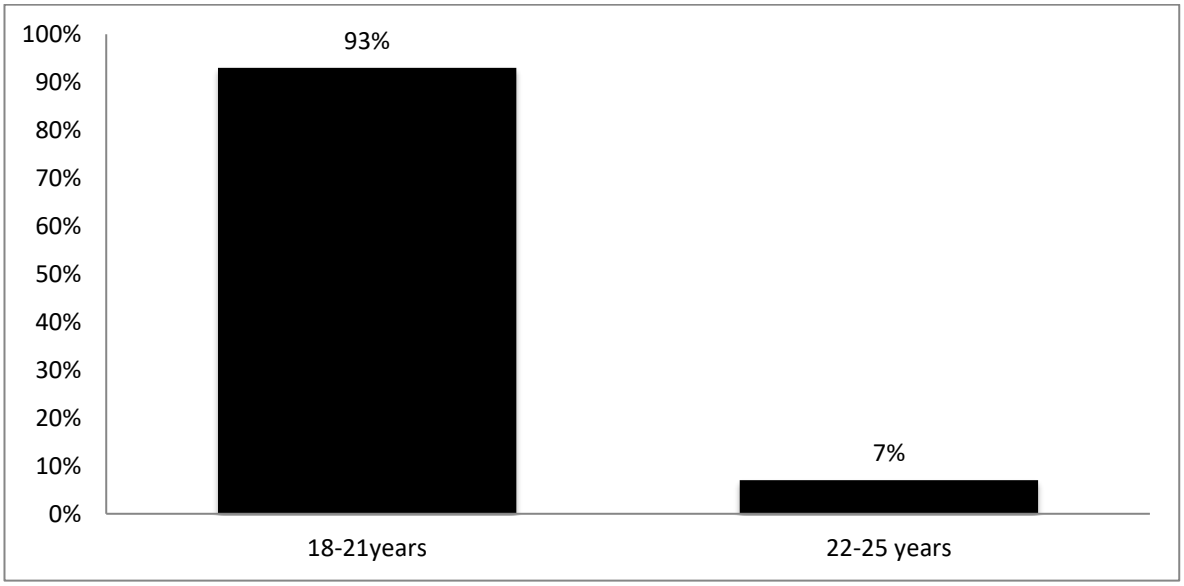


Figure 3-1: Demographics: Age

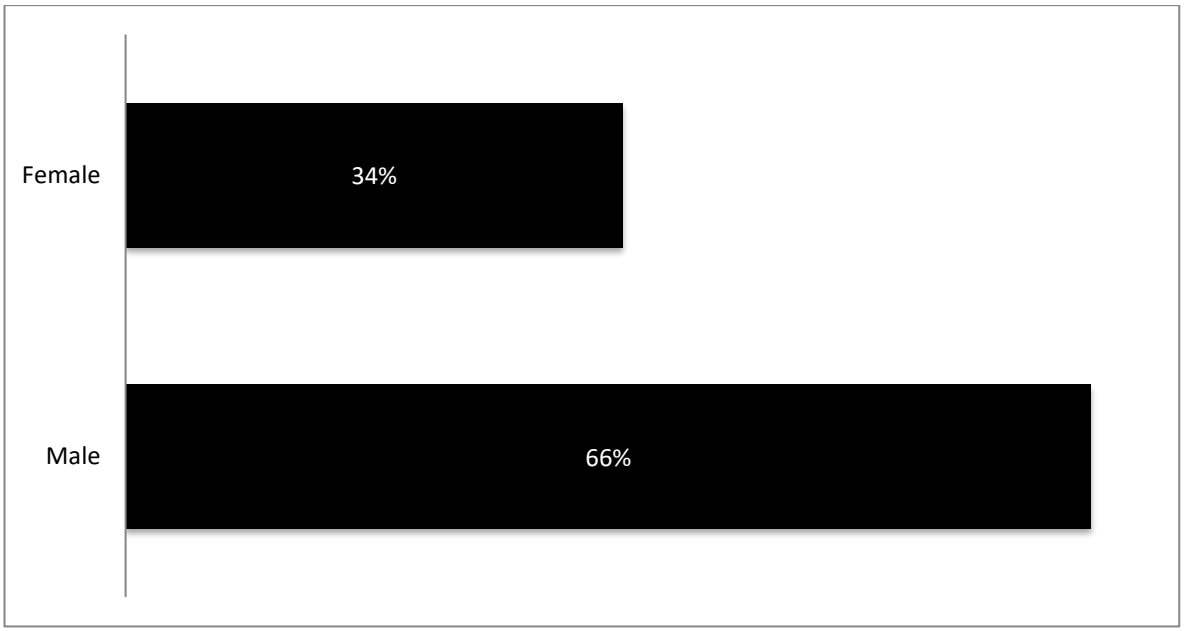


Figure 3-2: Demographics: Gender

3.2.2.2. Respondents' answers about current note taking activity

Figure 3-3 illustrates the respondents' answers regarding the importance of note taking activity. The results showed that 70% of respondents considered note taking as either 'important' or 'extremely important' in the classroom, while a total of only 12% saw less importance in note taking during lectures.

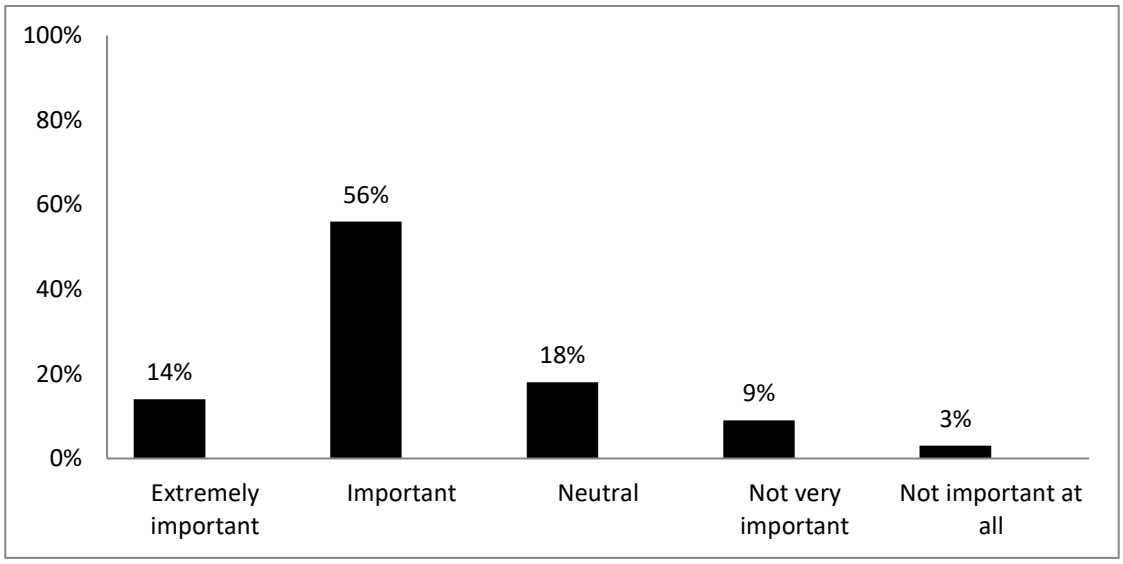


Figure 3-3: The importance of note taking during lectures

Figure 3-4 illustrates the difference in note taking habits amongst the undergraduate students surveyed. The results showed how often students take notes during lectures, with the notable finding that 95% of the respondents do take notes occasionally or frequently during lectures, while only 5% do not. It is worth noting that those who had never taken notes indicated the reasons for not doing so; this was mainly because they could easily find materials online.

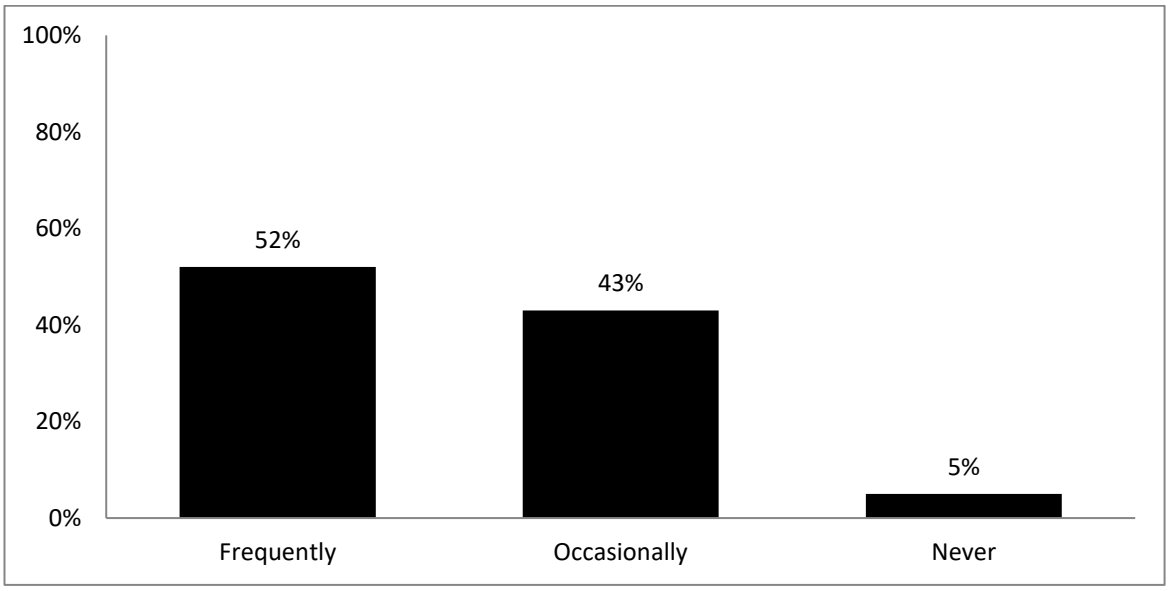


Figure 3-4: The use of note taking during lectures

Figure 3-5 shows the percentage of respondents who asked their friends for their notes and those who did not. The majority of the respondents, 53%, indicated that they asked their friends for their notes. The remainder, 47% of the respondents, indicated that they did not ask their friends for their notes.

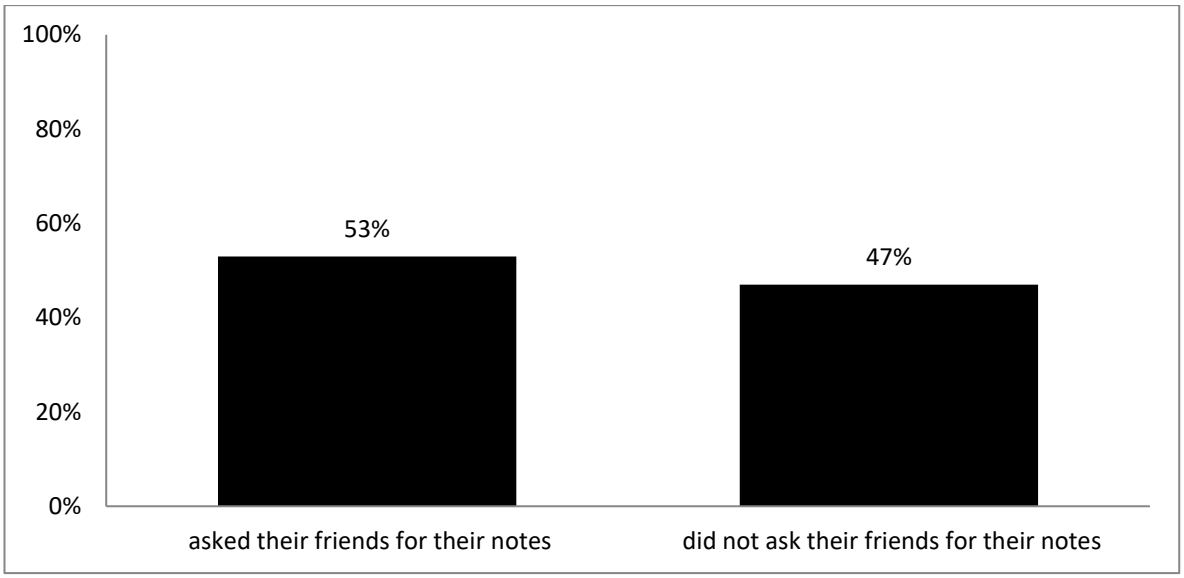


Figure 3-5: The percentage of respondents who asked their friends for their notes

Figure 3-6 shows the respondents' answers in regards to the reasons why they asked their friends for their lecture notes. The analysis suggests that, for those who did ask their friends, 43% of respondents indicated that they did so because their own notes were not always complete, and 28% to check the accuracy of their taken notes. This was followed by 6% of the respondents who asked their friends for notes because they did not usually take notes themselves during lectures. The vast majority of the respondents chose other reasons, with 23% stating that they did so because they had missed one of the lectures.

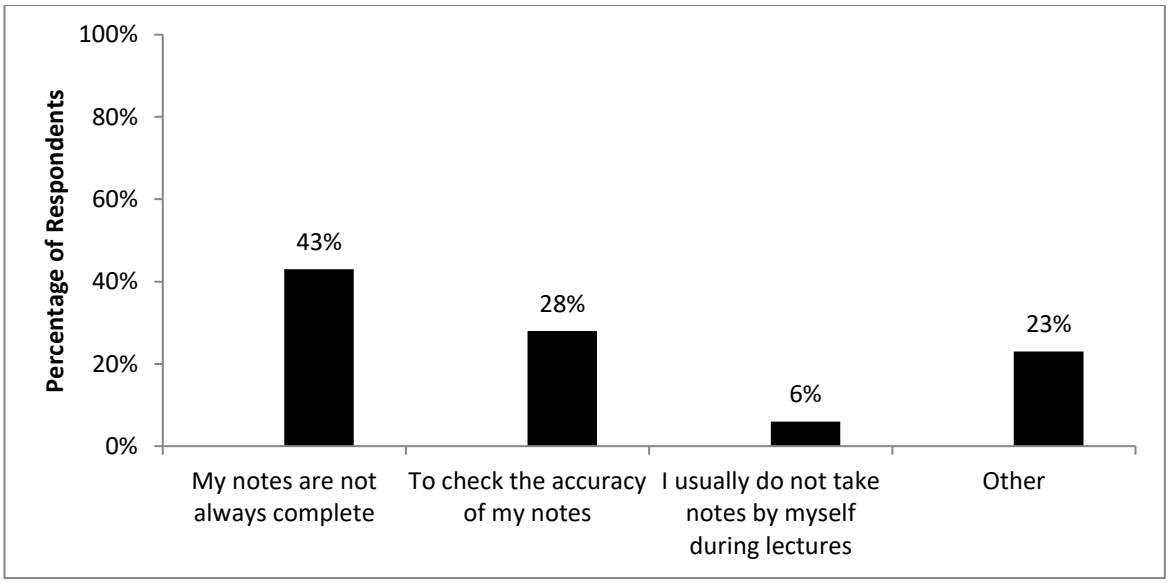


Figure 3-6: Reasons from students for asking their friends notes

Figure 3-7 shows the respondents' answers regarding the reasons for taking notes during lectures. For each reason for taking notes among the students, the following results were recorded. The majority of the respondents, 72%, reported capturing the important points during lectures as the main reason for taking notes in the classroom. In addition, 62% found that note taking is helpful in remembering the lectures and 58% reported that they take notes during lectures to review them later at exam time. Further, 49% of the students said that note taking increased the understanding of the lectures Moreover, 44% of respondents reported that note taking helped them to focus their attention on the lecture, while only 23% reported that note taking organised their ideas about the lectures.

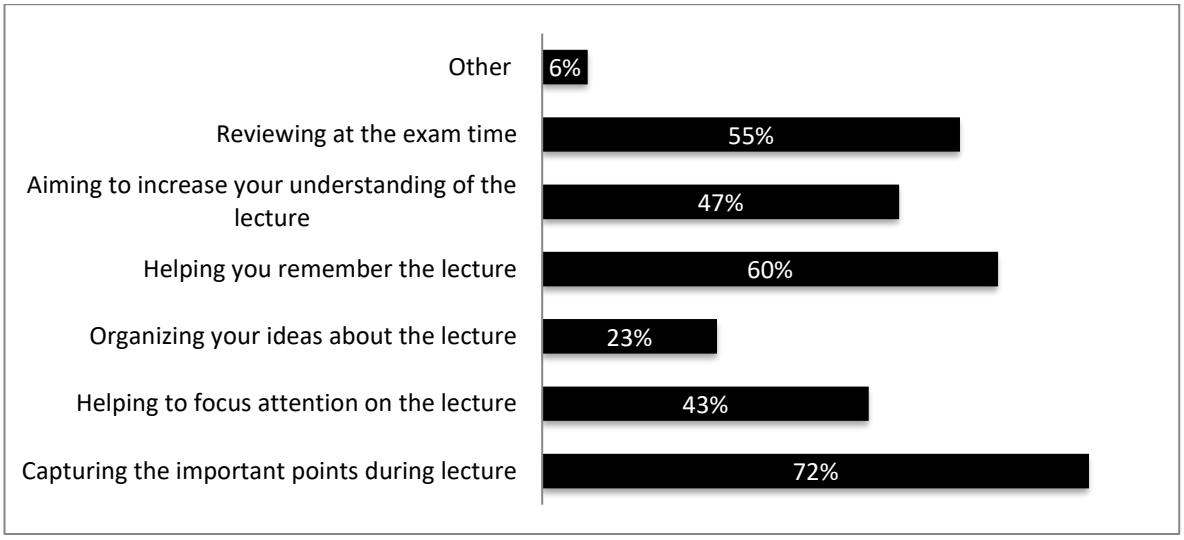


Figure 3-7: Reasons for note taking during lectures

Figure 3-8 illustrates the answers of the respondents regarding the factors that motivated them as students to take notes during lectures. The analysis shows that the most motivating factor, reported by 73% of respondents, was in relation to lecturers stressing a point for its importance during lectures. In contrast, only 61% of respondents found what lectures wrote on the board to be motivating for taking notes. In addition, around 58% found that difficult content motivated them to take notes, while 44% of respondents reported that this occurred when new material was introduced. Furthermore, 42% of the respondents found that the encouragement from the lecturer to take notes motivated

them. Only 5% reported that the motivation to take notes was mainly the lecturer saying something that was not available in the slides.

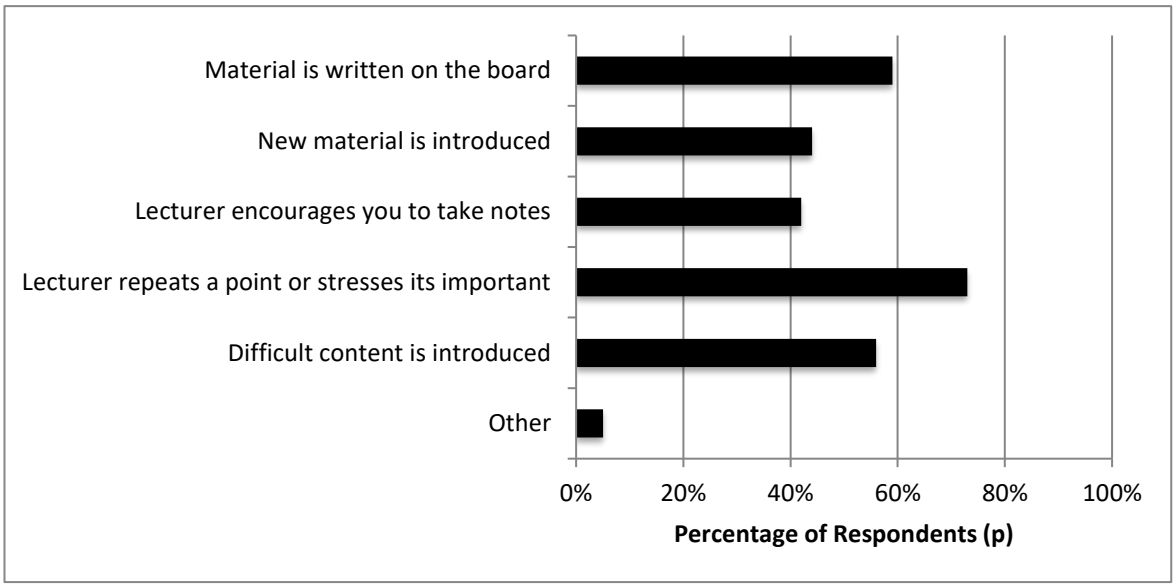


Figure 3-8: Motivational factors for taking notes during lectures

Figure 3-9 shows several note taking strategies that can be used by students during lectures. The highest number, almost 98%, used pen-paper for taking notes while only 12% of respondents used a note taking application (e.g. Evernote, OneNote, etc.). The other 29% of respondents used a word processor (e.g. Notepad, Microsoft Word, etc.) while 9% of the respondents used an audio recording.

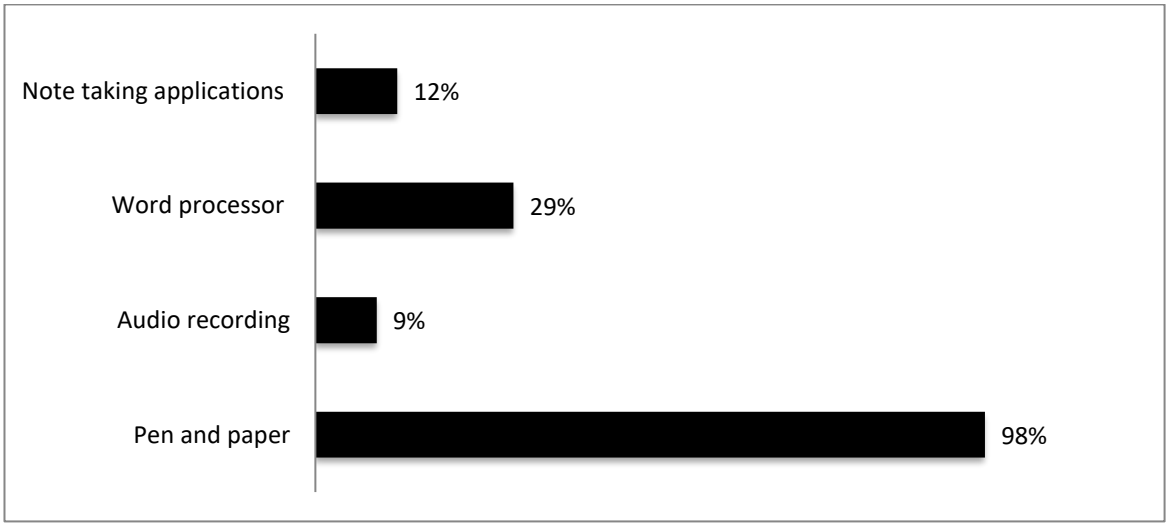


Figure 3-9: Note taking approaches used during lectures

Figure 3-10 shows whether or not students shared their notes with their friends. The majority of respondents, 60%, shared their notes with friends while 40% of respondents did not share their notes.

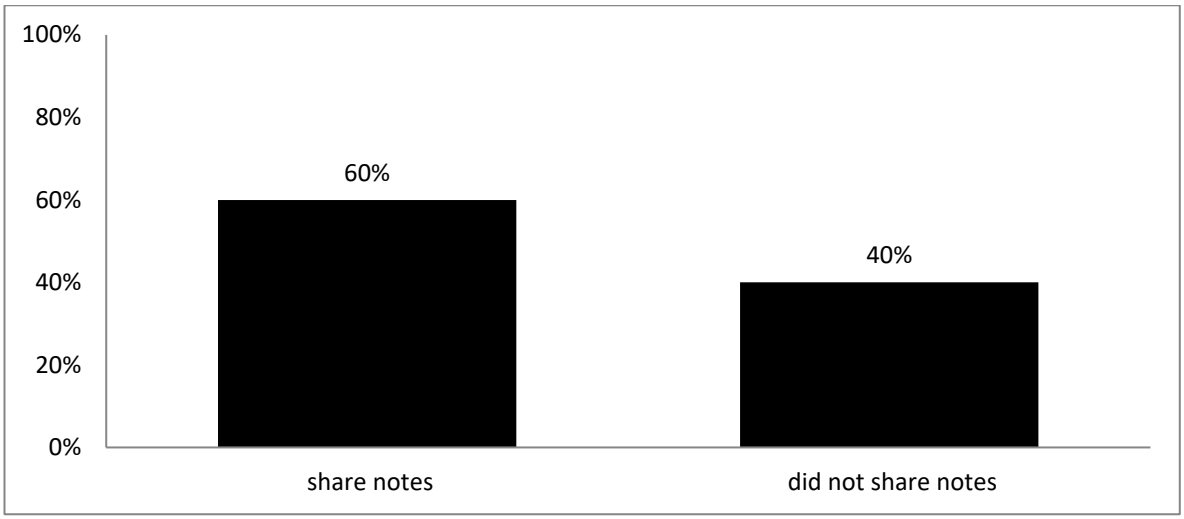


Figure 3-10: The percentage of students' who share their notes

Figure 3-11 demonstrates how students shared their notes. Respondents who indicated that they shared their notes were asked to indicate the method for sharing them. Almost 79% of the respondents lent the original copy of notes, and 17% used Web 2.0 platforms to share their notes. In addition, 21% of respondents photocopied their notes and 19% of respondents used email for sharing their notes. However, only 19% of the respondents used mobile phone cameras to share notes.

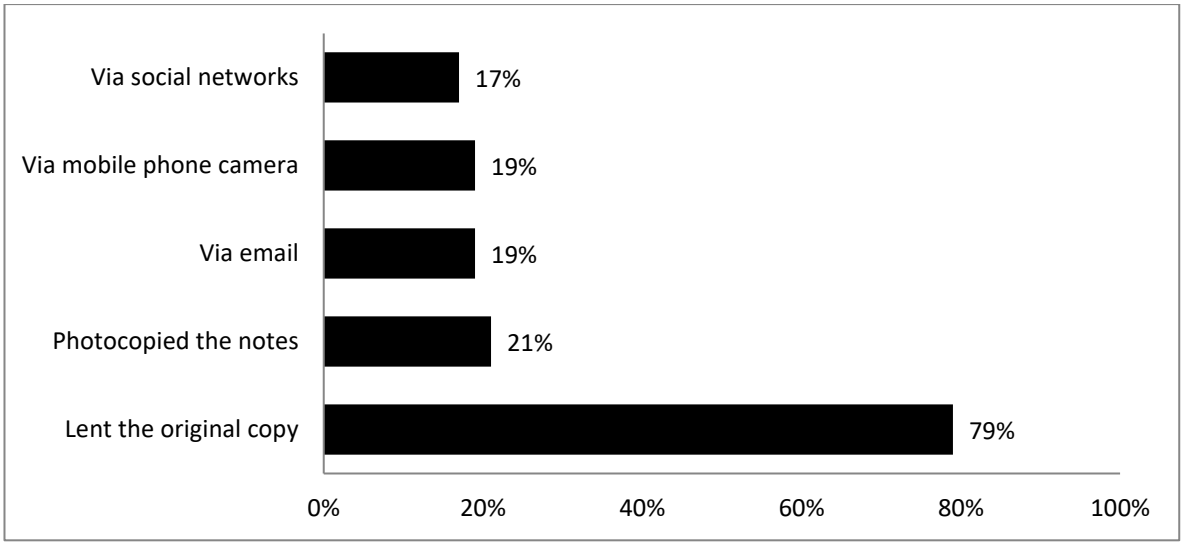


Figure 3-11: Methods for sharing notes between students

The 17% who shared their notes with their colleagues via Web 2.0 platforms were asked to indicate how they did so. Figure 3-12 shows that the majority, about 95% of respondents, used direct messaging to send notes while around 18% of respondents shared notes publicly on Web 2.0 platforms based on friends' requests.

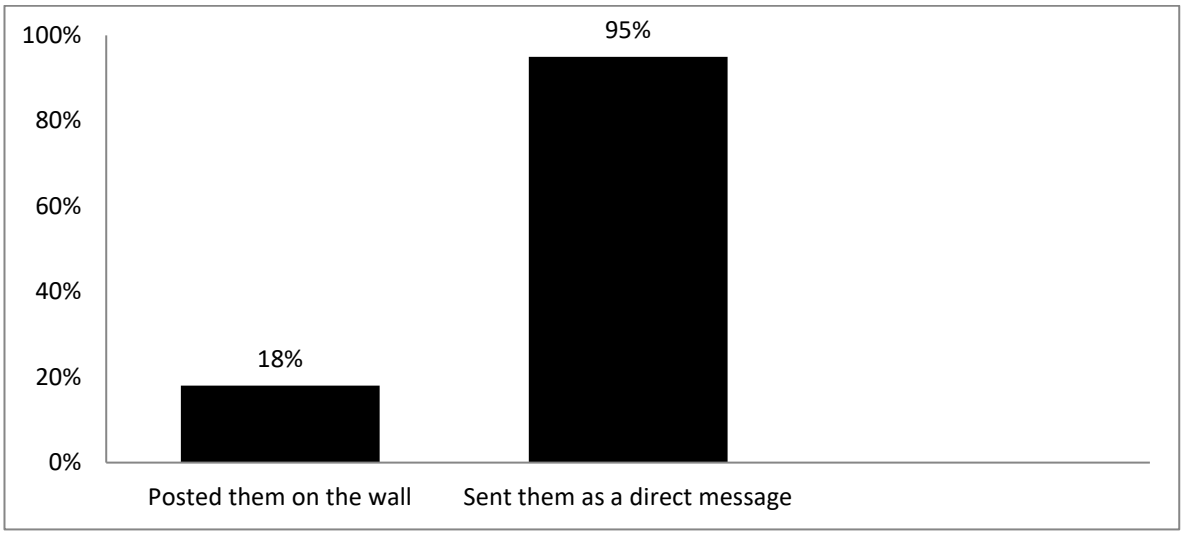


Figure 3-12: Methods for sharing the notes on Web 2.0

Figure 3-13 illustrates that there is a very low rate of students using note taking applications on their mobile devices, almost 15%. In addition, for students who indicated that they used a note taking application, pre-installed note pad (e.g. Notes on iPhone) application on mobile devices by phone manufactures is the most frequently used note application.

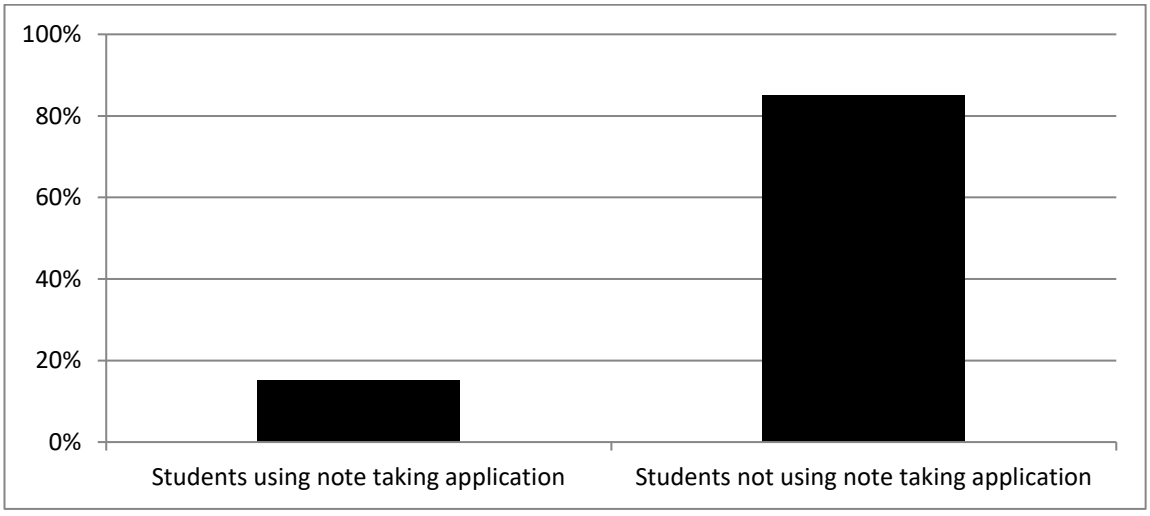


Figure 3-13: The use of note taking application

Figure 3-14 shows the reasons that prevent students from using note taking applications. Respondents who were not using note taking applications were asked to identify the reasons for not using them. The majority of respondents, 50%, agreed that lack of motivation was the main reason for not using note taking applications. Moreover, 35% of the respondents did not know about the existence of such dedicated applications for note-taking, while 33% found that the current note taking applications did not provide a convenient way to access the notes they had taken. This was followed by 11% of students who believed that note taking applications did not provide the required functionality, and also an equal percentage of 11% that perceived note taking applications as difficult to us. The small remaining 1% indicated that they could not interact with their friends using them. Finally, 17% identified other reasons such as preferring to use pen and paper.

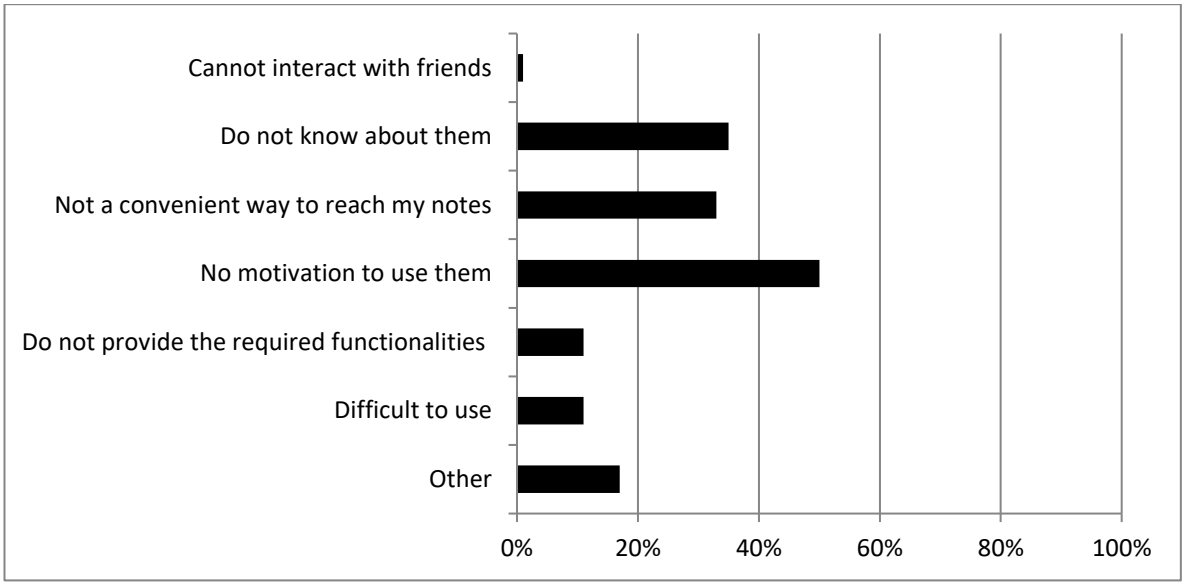


Figure 3-14: Reasons for not using note taking applications

There were, however, different mobile devices that the students carried into lectures, as illustrated in Figure 3-15. The analysis shows that the majority of students, 85%, carried smartphones into the classroom. Interestingly, only around 5% of the students in the "Other" category did not carry any type of mobile device into the classroom.

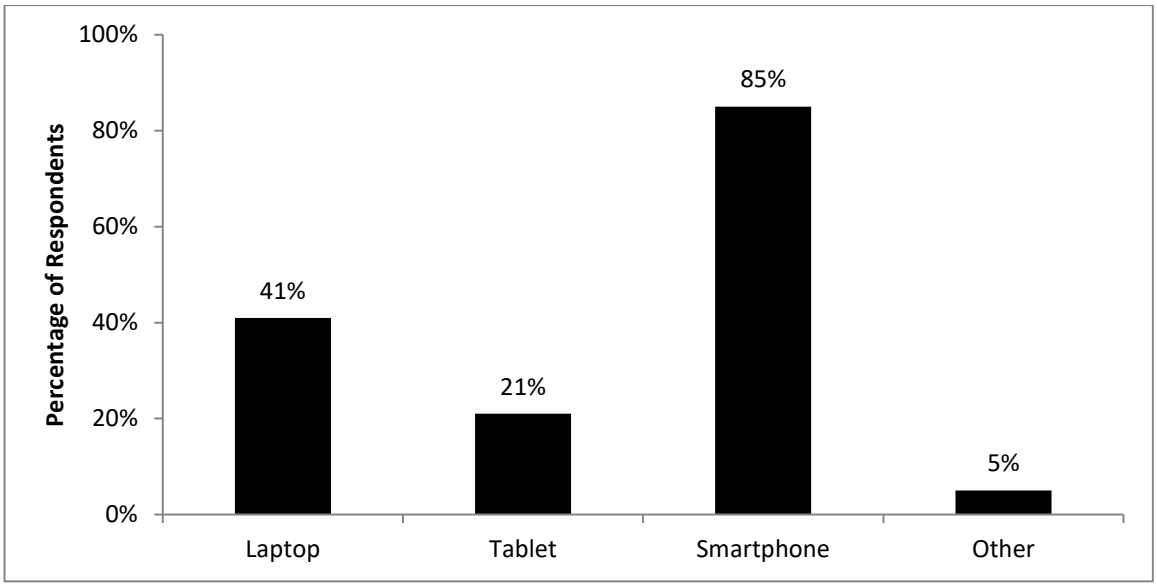


Figure 3-15: Type of mobile devices carried during lectures

3.2.2.3. Respondents' answers about the use of Web 2.0 platforms in the classroom

Figure 3-16 shows that there are different types of Web 2.0 platforms that are used by students. The vast majority, about 99% of those surveyed use Facebook, 65% use YouTube and 44% of the respondents use Twitter.

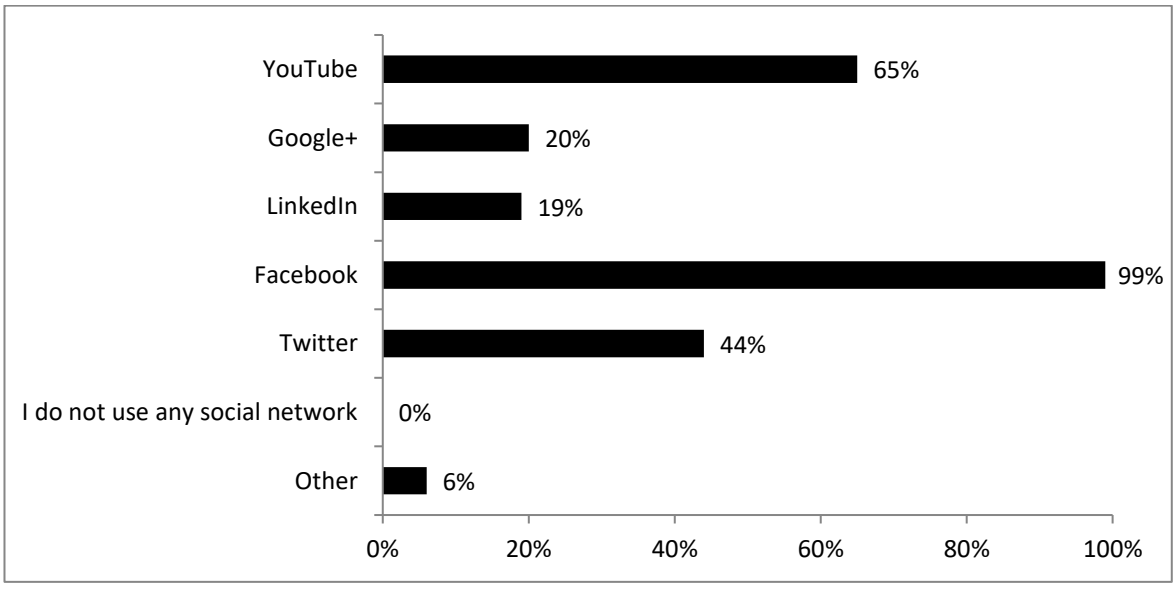


Figure 3-16: Most popular Web 2.0 platforms used among students

Figure 3-17 shows that the majority of respondents, 72%, access Web 2.0 platforms in the classroom and during lectures while 28% do not access them.

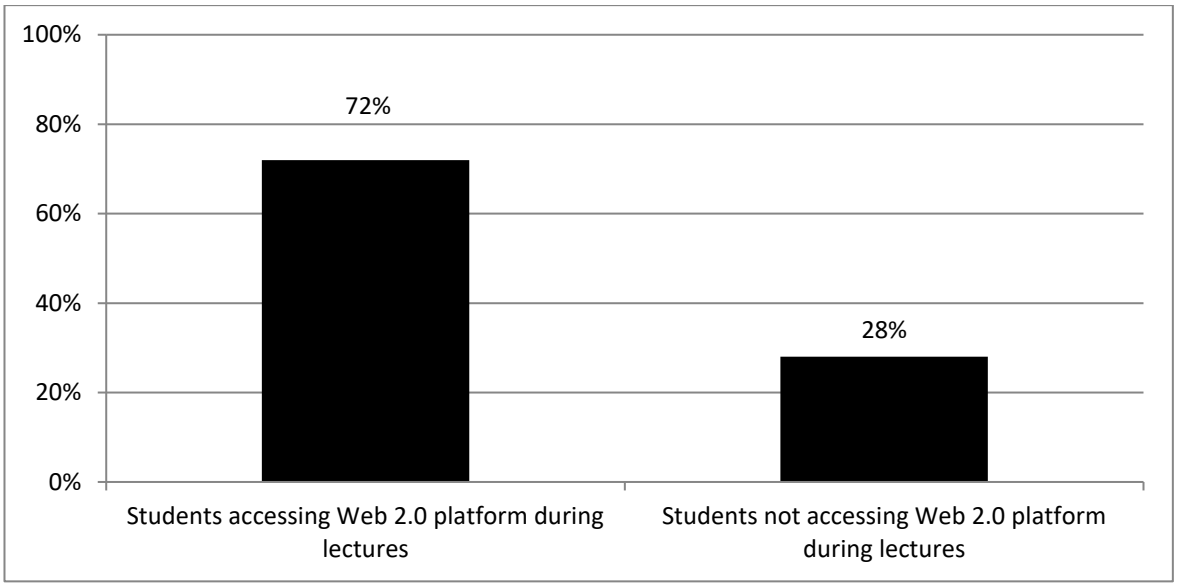


Figure 3-17: The Percentage of students who accessed Web 2.0 platforms in classrooms

Figure 3-18 illustrates some of the reasons why students access Web 2.0 platforms during lectures. Respondents who accessed Web 2.0 in the classroom were asked to identify the most frequent reasons for doing so. Most of the respondents, 85%, accessed Web 2.0 platforms for checking the latest posts or news, while 22% of respondents accessed Web 2.0 platforms for educational purposes (e.g. discussion and asking questions).

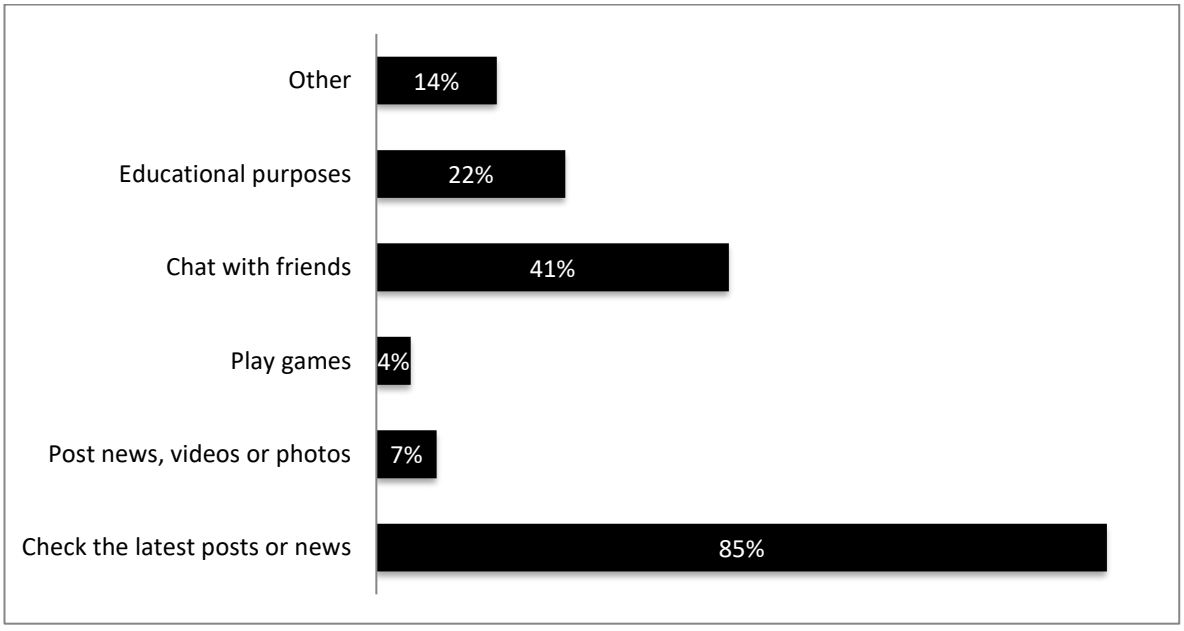


Figure 3-18: Reasons for accessing Web 2.0 applications in classroom

Figure 3-17 above illustrated that 28% of the students surveyed do not access Web 2.0 during lectures. Figure 3- 19 gives some of the reasons for not accessing Web 2.0

applications in the classroom. Most students, 84% indicated that accessing Web 2.0 platforms would distract their attention during lectures. In addition, 57% of students indicated that there was no educational value in accessing these platforms during lectures. This was followed by 26% of students who indicated that accessing Web 2.0 platforms in a classroom would be time consuming.

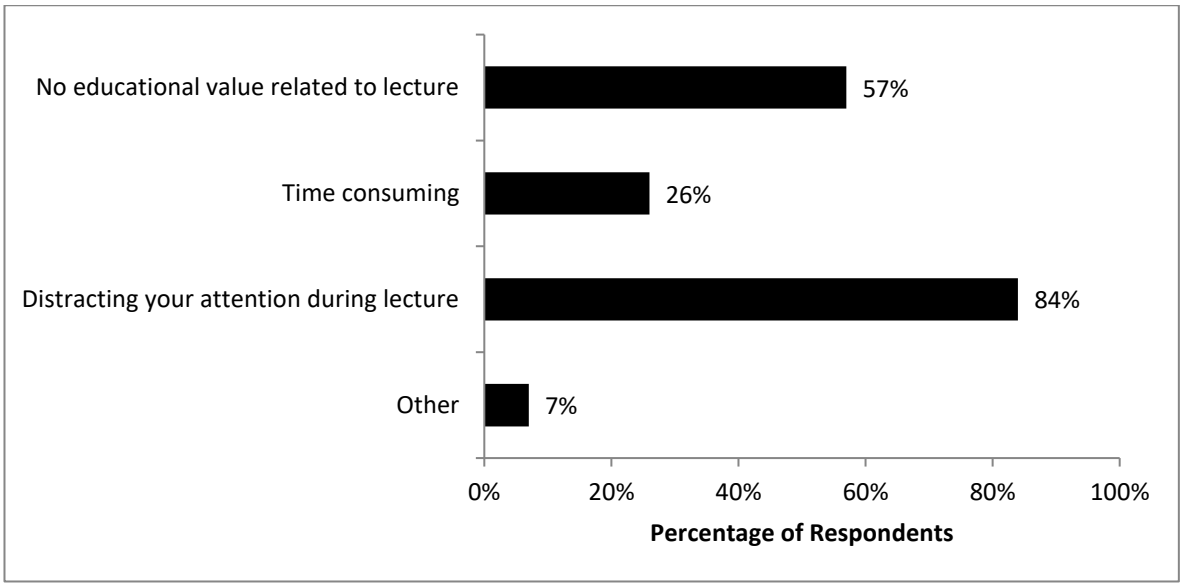


Figure 3-19: Reasons for not accessing Web 2.0 applications in classroom

3.2.2.4. Respondents' perceptions of integrating Web 2.0 features for new mobile note taking application

Figure 3-20 shows how many students would have appreciated an application that offered a note sharing feature to share notes between students in the classroom. The majority of students, 74%, stated that they would appreciate such an application, whereas 26% of students did not feel that this was particularly important.

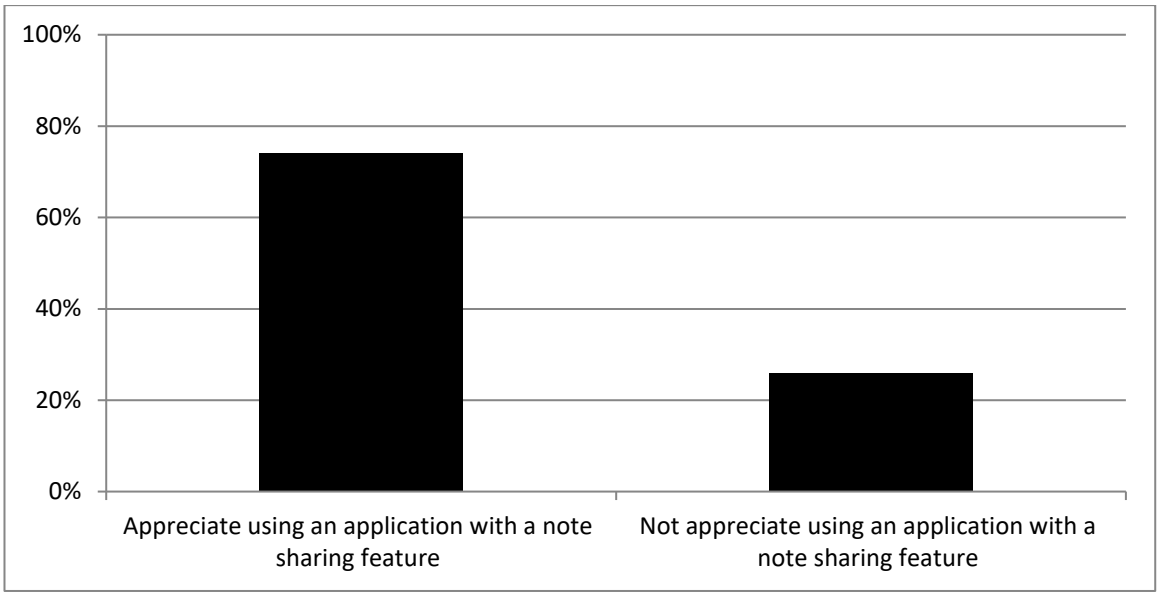


Figure 3-20: Students that appreciate using a mobile note taking application with a note sharing feature

Figure 3-21 illustrates students' future preference for either using traditional pen and paper note taking or a mobile note taking application. The results show that 57% of students preferred to use pen and paper in the future, while only 43% of students preferred to use mobile applications as a note taking approach.

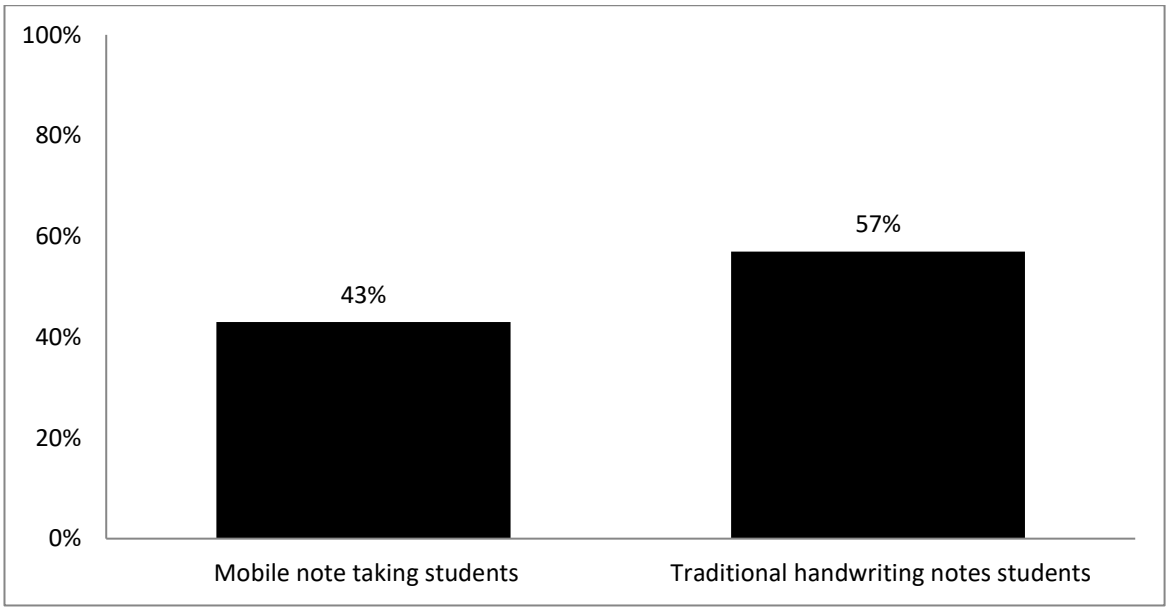


Figure 3-21: Students' future preference to use note taking approaches

Moreover, additional analysis was conducted to identify the important features perceived by students that agreed on using a mobile note taking application. Figure 3-22 illustrates

respondents' opinions in regards to four Web 2.0 features that were perceived as important in a new mobile note taking application. These four features were as follows: social interaction (e.g. comments, like/dislike, etc.), rich media (e.g. videos, audios and photos), sharing notes and posting short notes.

The analysis showed that the highest percentage of students, 25%, found short notes to be the most important feature in a new mobile note taking application. Moreover, 18% found sharing notes to be the next most important feature. This was followed by 11% that found rich media to be important. Only 7% of students perceive social interactions as the least important feature.

In addition, students also reported through the qualitative question some reasons for not including for example sharing features in a new application; for example: "*If note taking was social people would just copy rather than making their own notes". "notes are unique, e.g. use shorthand that others may not understand, people understand things differently -> will need different explanation in their own notes".* Although overall, students seemed to like note sharing (Figure *3-22*), due to their concerns in the qualitative responses, it was decided that the sharing feature should not be included in the new application.

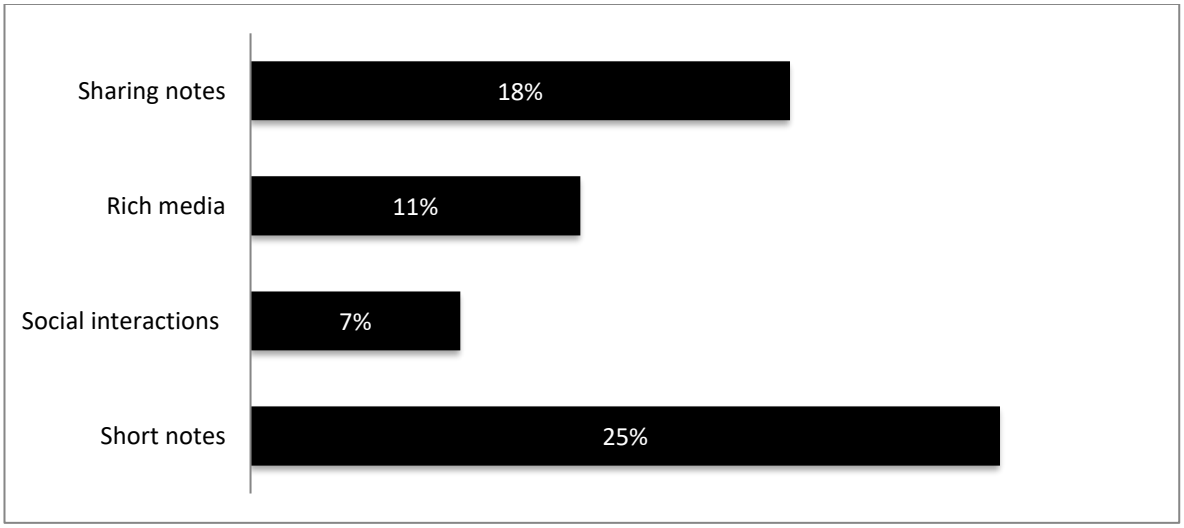


Figure 3-22: Students' perception of different features of Web 2.0

Figure 3-23 illustrates students' opinions towards the most suitable Web 2.0 platform to adopt a new note taking application. This shows that 54% of students perceived Twitter as the most preferable platform in regards to suitable features to be used in a new note taking application. This was followed by 24% for Facebook and 22% for the remaining platforms.

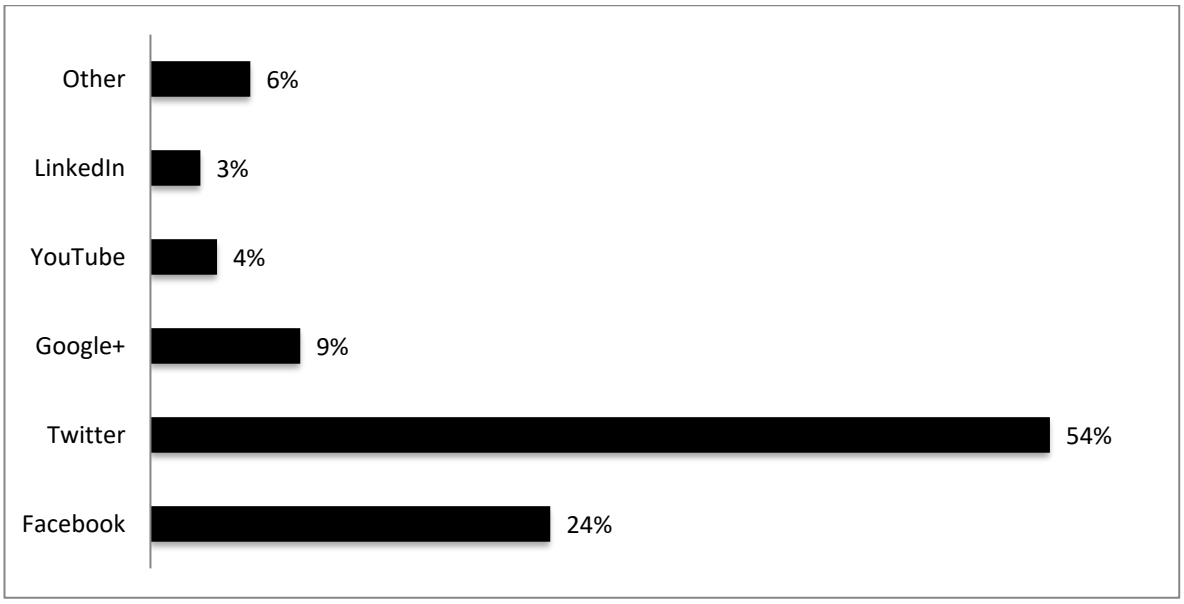


Figure 3-23: Web 2.0 features platforms to use for new note taking application

3.3 Discussion

The aim of this study was to explore the current note taking activities by students, in addition to students' perception of using Web 2.0 features in a new note taking application. Therefore, based on the above analysis, conclusions have been drawn based on three parts: note taking, mobile and microblogging.

- **Current note taking activities**

The associated results in Figure 3-24 show that 95% of students take notes in the classroom. Somewhat surprising, the traditional pen and paper is still the favourite method where 98% of students use it. In addition, 70% of students indicted that they took notes because they perceived the activity to be important. However, 53% of students reported

that they asked their friends for their notes. This is because of the fact that students reported in the survey that their notes were 43% incomplete and 28% inaccurate.

The analysis shows that although students perceived note taking as important, the majority of students still used the traditional pen and paper approach for note taking, despite the huge advancement in technology and mobile smartphones. Moreover, an important point that should be noted here is that even though students had been using pen and paper to take notes, they still required the use of their friends' notes to complete their own notes and to check if they had taken accurate notes. This shows that there is an issue with the traditional way in which students take notes, which is the dominant note taking method.

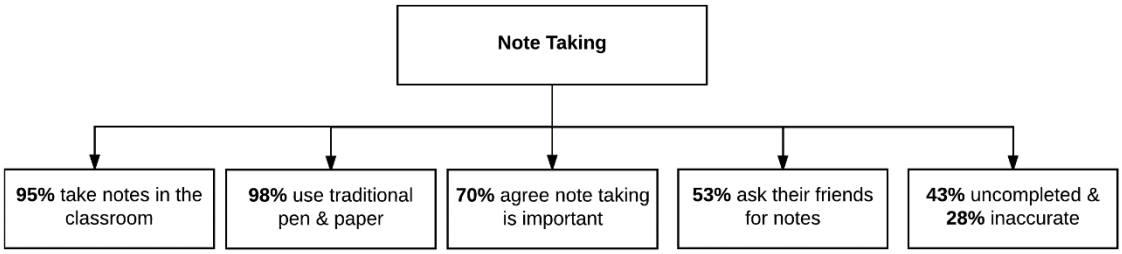


Figure 3-24: Outcomes from students' perspective for current note taking

- **Mobile smartphones in the classroom**

The associated results in figure 3-25 show that 15% of students use mobile note taking applications, although 85% of the students carry a smartphone in the classroom. Half of the students reported that this was due to the lack of motivation to use note taking applications. However, 72% of students reported that they used their mobile phones to access Web 2.0 platforms in the classroom. Yet 43% of students indicated that they would prefer to use a new mobile note taking application in the future.

The analysis shows that although students used their mobile device to access Web 2.0 platforms in the classroom, only very few would use mobile note taking applications. Moreover, an important point that should be noted here is that not all students find any

motivation in using mobile note taking application although the majority carry a smartphone in the classroom. This shows that current mobile note taking applications are not offering students the experience that Web 2.0 platforms are doing. This clearly indicates that there is a need to integrate some of the features the students find motivating in Web 2.0 platforms to be used in mobile note taking applications. This could change students' perspective towards mobile note taking, since 43% would consider using a new mobile note taking application in the future.

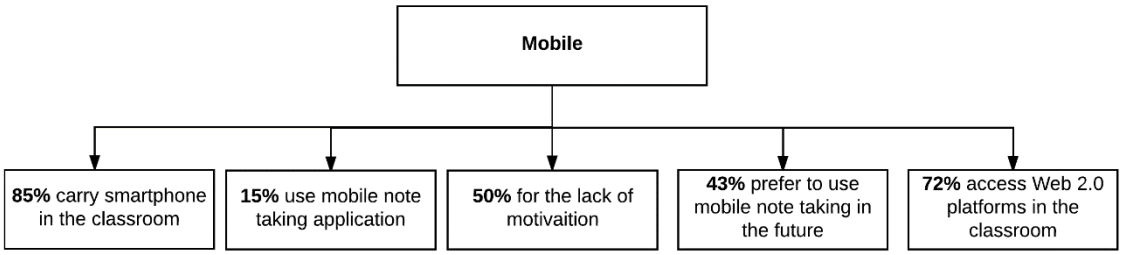


Figure 3-25: Outcomes from students' perspective for mobile smartphones

- **Microblogging feature in new note taking**

The associated results in figure 3-26 show that 75% of students take notes of important points mentioned by lecturers in the classroom. In addition, 56% of students reported that they perceived short notes to be a very important feature of a new mobile note taking application. Moreover, although all students used at least one Web 2.0 platform, only 22% had accessed them for educational purposes. However, 54% of students, the majority, reported that they would prefer to use features from Twitter in a new mobile note taking application.

The analysis shows that students find short notes to be a very important feature and, at the same time, recording the most important points in the lecture was considered by the students to be the main reason for taking notes. These, in addition to the majority of students' preferences for adopting Twitter's features in a new mobile note taking

application (Figure *3-23*), support the research proposal in terms of using microblogging as a new feature for a mobile note taking application.

This analysis of students' preference may be associated with Twitter's short text feature of writing 140 characters. This provides a strong indication that the short limit of characters is a preferable feature for a note taking application.

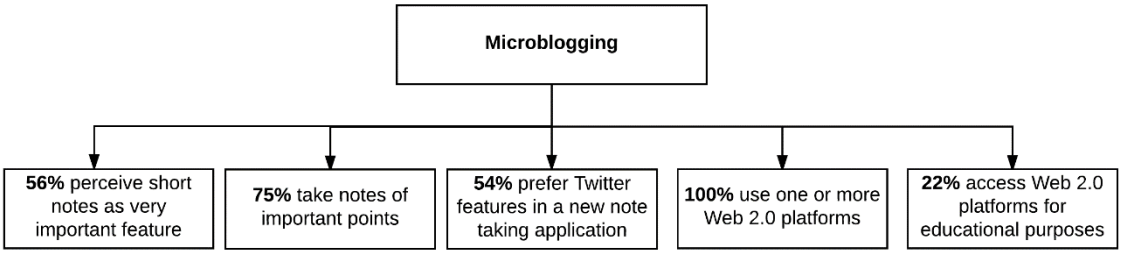


Figure 3-26: Outcomes from students' perspectives for microblogging

The final point in this discussion is in regards to the activity of sharing notes, which has not been found to be an issue when using the traditional note taking method of pen and paper. However, sharing notes may be considered to be one of the side effects caused by taking incomplete and inaccurate notes, the latter possibly being one of the crucial issues in note taking for students.

3.4 Summary

The investigative study conducted within this chapter addresses the first research question ***RQ1***: **What are the students' perspectives regarding mobile note taking applications in the classroom?** The answer to this question is drawn from the investigative study conducted above.

This chapter has investigated students' perspectives towards current note taking activities and mobile note taking applications in the classroom. Data collected from students about

note taking through the exploratory survey were analysed using descriptive analysis. This resulted in outcomes and insights into three key aspects: note taking, mobile devices and microblogging technology.

The next chapter will develop a note taking application based on the findings of this chapter. This involves the design and development of a note taking application that includes a short note feature based on microblogging technology.

Chapter 4

4 Development of the Mobile Micro Note Taking Application (M2NT)

4.1 Introduction

In the previous chapter, an investigative study was carried out with students to identify their current note taking activities in the classroom. In addition, the study identified that notes taken by students are perceived to be incomplete and inaccurate. Moreover, the study went further, to explore the features that might motivate students to take notes using their mobile devices in the classroom.

The insights and findings from the previous chapter will be used as input into this chapter. Therefore, this chapter focuses on designing and developing an application as a new mobile note taking approach. This involves the integration of a microblogging feature to take notes using mobile devices which is called, in this research, micro notes.

This chapter aims to meet the third research objective **OB3**. This is achieved through the development of a mobile micro note taking application.

4.2 The Mobile Micro Note Taking Application

Mobile Micro Note Taking (M2NT) is a mobile application that allows students to take 140 character notes on their mobile devices in the classroom. These notes in this research are defined as “micro notes”, which are short digital texts, also described as micro-content.

The concept of micro notes was derived from the investigative study in this research (see Chapter 3). The insights into the investigative study showed that students support the use of short notes, and at the same time, perceive Twitter’s features as desirable for the design of a new mobile note taking application (Figure 3-23). Therefore, the research

found that microblogging may meet students' expectations in regards to the design of a new Web 2.0 mobile note taking application. This chapter introduces the design of micro notes that have been adopted from the short content creation feature of microblogging and deployed in the mobile application.

However, it is important to note that the focus of this research is based only on one feature of microblogging, namely short content creation (Figure *3-21*). Therefore, the other features of microblogging, which involve social features, have not been taken into account in the design of this study based on the students' qualitative answers (see section 3.2.2.4). Moreover, the researcher has decided to introduce the short content creation feature in a new application Figure *3-22*. The aim of the research application focuses on the note capturing activity, which is met by the short content creation feature of microblogging (i.e., micro notes).

In addition, although Twitter is the most used and known application by students that use microblogging technology, it does not meet the research requirements of a micro note taking application that could serve educational purposes Figure *3-19* [8]. This is in relation to students' perceptions Figure *3-19*, which finds Web 2.0 platforms a distraction in the classroom [92]. Therefore, Twitter has not been chosen to conduct this research, although it is the most popular microblogging platform. Thus, a new design for a micro note taking application was required to take this research forward.

Although the feature of limiting users to just 140 characters per entry (i.e. note) is a unique feature of microblogging [119], the use of this feature has not been explored thoroughly in classrooms as a note taking approach. To the best of our knowledge, none of the previous research work suggested the idea of note taking through a microblogging feature as micro notes in a mobile note taking application. Moreover, no research has used micro notes as a capturing approach for note taking activity in a class setting at university level, or in relation to students' experience. Furthermore, the existing apps on the market, such as

Evernote and OneNote, do not include the feature of microblogging short text Table *2-1*, as mentioned in chapter 2.

The M2NT application aims to address the following facts found from the investigative study:

- Students still use pen and paper as a dominant note taking approach. Although not necessarily bad, this is far from being a good tool;
- Students do not use modern technology efficiently (e.g. mobile and Web 2.0.) for note taking activities during lectures;
- Students carry their smartphone mobile devices in the classroom, but few use it to take notes;
- Students perceive short notes as a very important feature of a new mobile note taking application.

In addition, the development of a mobile micro note taking application is based on facts that are gleaned from literature reviews regarding the benefits of technology in learning. Web 2.0 technology can enhance learning activities in class, although short text microblogging has not been utilised specifically for note taking activity.

Therefore, a need emerged to design an application that employs the short text feature of microblogging (i.e. micro notes) so that the students' experience in using the M2NT application in a classroom environment can be evaluated. The remaining part of this chapter will describe the process of development of the M2NT application.

4.2.1. Methodology

There are many models of life cycle for software development. The waterfall model is one of the most commonly used to develop software [127]. The waterfall model was selected to develop the application in this research. This choice of model was influenced by a sequential design process for the application development [126]. The waterfall model provided guidance for developing the application, as it follows simple planned and sequential phases to deliver at the end the means for gathering outcomes via the

evaluation [127]. The requirements explored from the users are one of the waterfall model phases. The requirements of the application are represented in the next section.

4.2.2. Requirements for the Application

In the light of the literature review, the requirements for application development are extracted from the investigative study outcomes, as discussed in chapter 3 (See section 3.3). However, they can be summarised as follows.

1. The application should use Web 2.0 technologies to motivate students to access the mobile note taking application in the classroom.
2. The application should use a short note feature based on Web 2.0 technologies (i.e. microblogging) as a note capturing/recording technique.
3. The application should be implemented on mobile smartphones so that most students can use it.
4. The application should adopt features from Twitter that can be integrated in the application.
5. The application should be designed for educational purposes for students to take notes in the classroom.

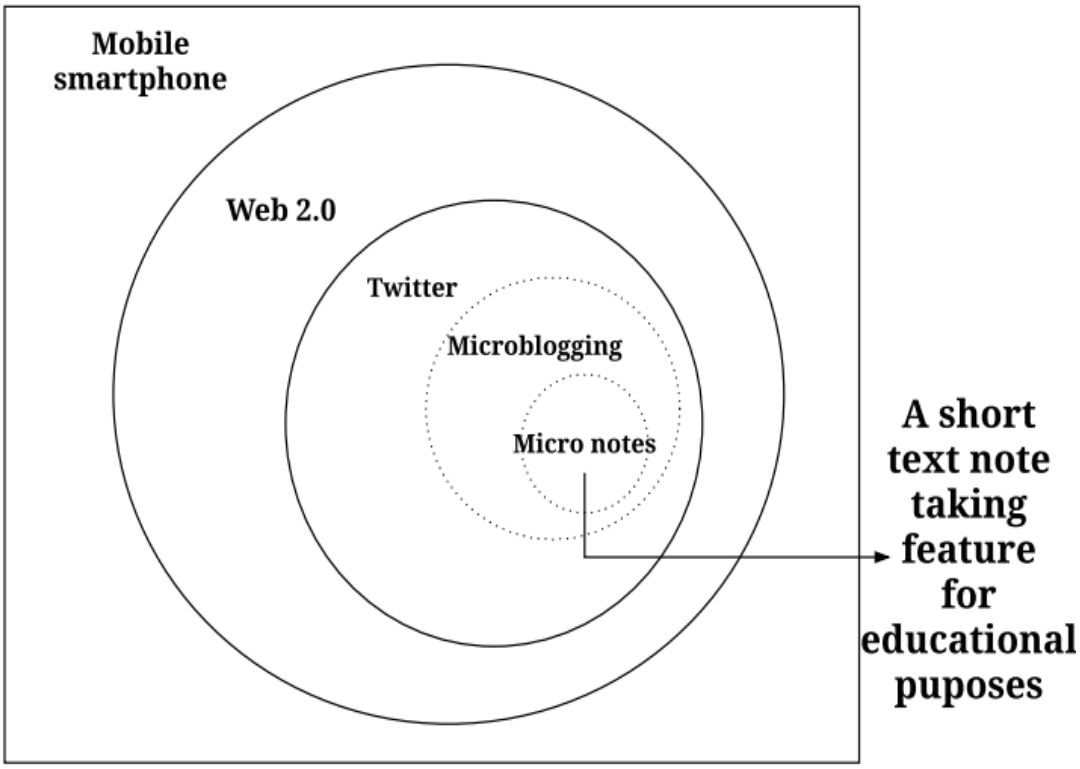


Figure 4-1: M2NT requirement illustration

From the insights and outcomes of the investigative study, the requirements of the application development are driven to design the M2NT application. The M2NT consists of a micro note feature that is based on Web 2.0 microblogging technology, and this also matches the Twitter posting feature of 140 characters. This is illustrated in Figure 4-1, which shows how the different aspects of the requirements formulate the M2NT application.

4.2.3. Design and Architecture

Using pen and paper is a simple, old fashioned approach, and the most common one for note taking. However, although it has its advantages, it is not the most effective tool for note taking. A simple approach is developed for the students, which is based on the short content creation feature for notes to be taken by the individual student on a smartphone in class. The application limits students to writing a short version of their notes.

The application architecture was basically built upon two main resources: the facts that demonstrate the benefits of technology from the literature review, as discussed earlier in Chapter 2, and the findings of the investigative study that were carried out in Chapter 3. A three-tier architecture was used, based on a client-server architecture that was adopted to describe clearly the operations of the application.

The proposed architecture was established based on Model-View-Controller (MCV) architecture. MVC architecture has been defined since the 70's by Smalltalk for object-oriented systems [153]. MVC architecture is a way of designing and implementing an interactive application [154]. To understand the MVC architecture, the application has been divided into three layered parts: Model, View and Controller [155]. (see Figure 4-2).

Models represent the load of data application that users deal with. Relating to the model layer, as the transferred data is limited to just 140 characters for each note, the load and data transfer become tolerable to the server, and cause no latency. Views are responsible for displaying the elements of the data model to the users interface. Controllers are responsible for processing the incoming users' requests, performing the operations on the model and choosing views for the user.

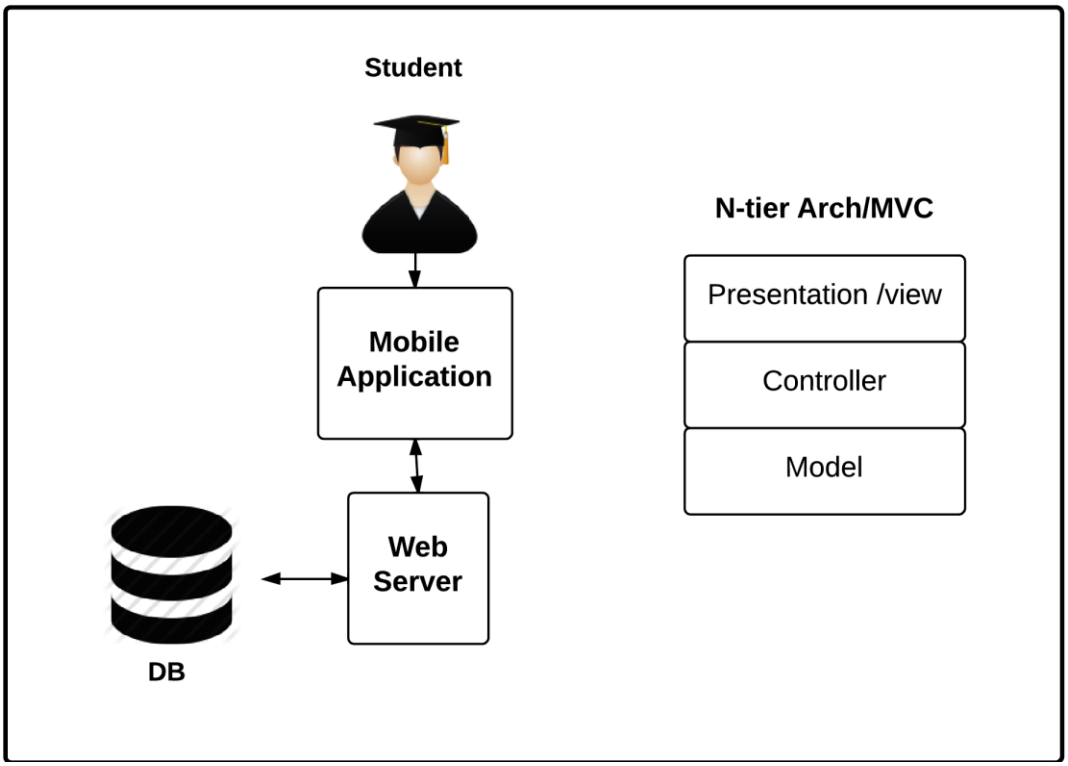


Figure 4-2: The M2NT Application Architecture

In this chapter Figure 4-3 describes the proposed application architecture.

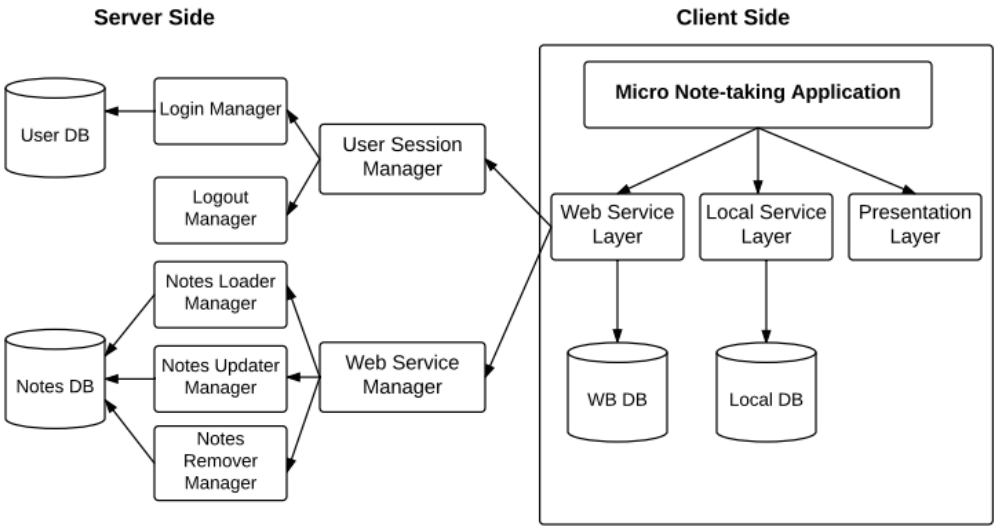


Figure 4-3: Description of M2NT Application Architecture

The overall purpose of this architecture was to develop a micro note taking approach for notes that is captured by just typing 140 characters for each note on smartphone devices, while the information is being presented in lectures.

The following is a detailed component description for the proposed application architecture of the client side (Table 4-1).

Table 4-1: The client side of the proposed application architecture

Client Side	
Web Services Layer	In this layer the Client calls all the required web services from the server such as; login, logout, load notes, open note, update note, delete note and validate session.
Web Services Database	This DB will store the data used by the WS (cache the loaded notes to save data plans).
Local Service	This layer is responsible for local device services such as: checking if session is alive and cache local user information and local passwords for later use.
Local Service database	This database is used by the local services layer.
Presentation layer	This layer is used to represent the data from both WS and local layers, also represent all the user controller layer.

The following is a detailed component description for the proposed application architecture of the server side: (Table 4-2).

Table 4-2: The server side of the proposed application architecture

Server Side	
User Session Manager	This Manager will keep track of all opened users and provide the necessary functions to perform the login logout services for the users.
Login Manager	This manager will validate user login information across DB (user name and password).
Logout Manager	This will delete all the meta data for the logged out user.
Web services Manager	This manager will handle all the requests related to the notes from the client side.
Notes Loader	This will load notes from DB for a user.
Notes Updater Manager	This will update a note.
Note Remover	This will delete all the requested notes from the DB.
Users DB	This database holds all users' information such as user-name and password.
Notes DB	This database holds all the information about all notes and the key for the owner user.

4.2.4. Implementation Details

The proposed architecture discussed in the previous section was used to implement the prototype of the application for note taking activity in education. This section focuses on the implementation of the application. The following explains in detail the steps that have been followed to develop the application.

Figure 4-4 in this chapter describes further the dataflow for a mobile micro note taking application.

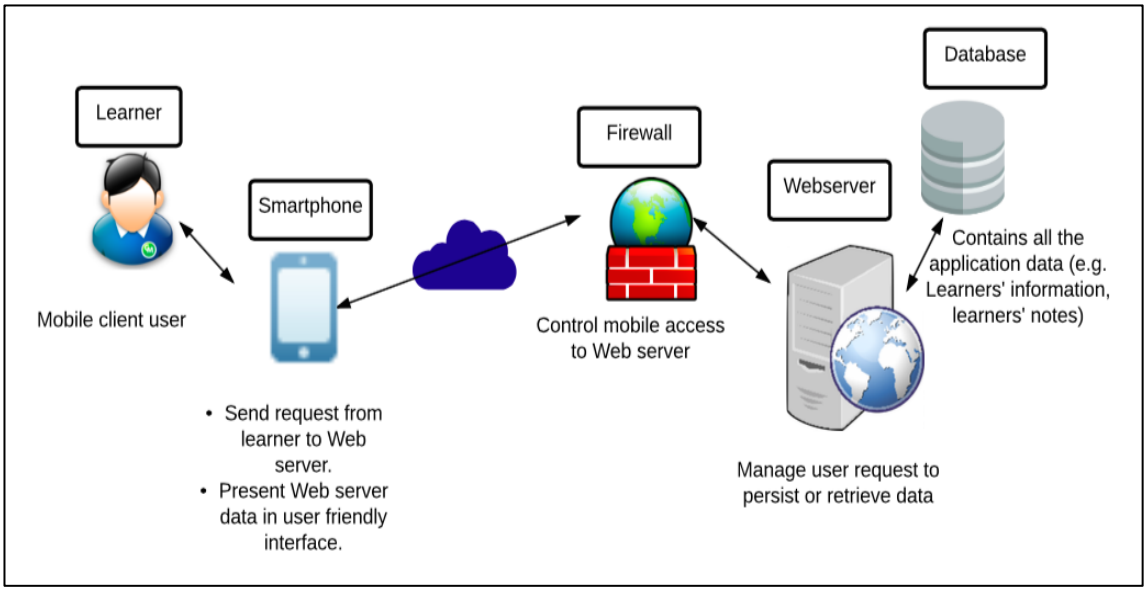


Figure 4-4: Dataflow for a micro note taking application

The application limited students to typing the notes in a short version composed of 140 characters each. A student via a smartphone device can access, edit, delete and view their micro notes and search. A firewall is used to control and monitor mobile access to the web server. The web server manages user requests such as: adding new micro notes, editing notes, viewing micro notes in order to continue with or retrieve data. The database contains all the application data (e.g. students' information such as username and password, students' micro notes).

The application was developed in this thesis on the Android platform with the popular open source software, Eclipse IDE [156]. Further details and justification for the choices have been mentioned earlier in Section 1.5.2. The GUI layout of the application was designed using the web design and development application, Webstorm. In order to start developing a cross-platform mobile application (a single code base which works among different mobile platforms), the PhoneGap framework was chosen to create a "hybrid app" that is web based ported through this tool to the native environment of the smartphone

[157]. PhoneGap is an open source framework that offers developers an environment where they can create apps in HTML, CSS and JavaScript, and still call on native device features [158]. HTML 5, JavaScript and CSS3 were used to develop the PhoneGap micro note taking application [159].

HTML is the main mark-up language for webpages [160]. HTML 5 is a powerful application, programming APIs for a richer Internet application [161]. HTML 5 was used to design the application interface that can be used with JavaScript [159]. Ghatol et al. [159] argued that HTML/CSS3 are emerging web technologies. CSS3 is the modern standard technology in the web world. HTML/CSS was also used for designing the user interface, e.g., colour and layout.

The application was uploaded to Google Store. The application was provided freely to download.

4.2.4.1. Use Cases of M2NT Application

A use case diagram was used to describe the desired functionality of the software product [162]. There are three main actors presented in Annex III. The student was the first actor, the mobile client user was the second actor, and the third actor was the webserver. These three actors were the main actors of the use case diagrams for a proposed micro note taking application. The purpose of use cases was to describe the actors that were brought together to perform the tasks for the application. The figures show the detailed description of the use case diagrams, including new notes, listing all the notes, editing the note and deleting notes, and can be found in Annex III.

4.2.4.2. M2NT Application Functions

The mobile application that was proposed was a mobile web based application (a client server). The application's main functionalities were as follows: writing new micro notes, searching for micro notes, editing the micro notes and deleting the micro notes. JavaScript was responsible for managing the client side communication with the web server.

The web server was developed using PHP5, which was used because it offers much-enhanced object programming functionality [159]. The web server used was the Apache server, as it suited our application best in terms of performance and security. MySQL was used as the database server.

All users' data from login information and notes content and metadata were stored on the database. The application used buttons (icons) that allowed the students to easily click and add a new micro note, edit a micro note, delete a micro note or search for a micro note and sign out. The basic functions were implemented for students so that they could take notes in just 140 characters. After the students signed in to the application, the student could view their micro notes or write a new micro note. The micro notes could also be edited or deleted by students if required. The students could also recall the micro notes for later use for any purposes such as revision.

The following is a pseudo code illustrating the main function of M2NT performed by the students, which takes notes in 140 characters in the mobile application as follows.

Client

1. Open text area.
2. Load note text to text area // if new note it will be empty
3. Set chars_count to text area text length
4. Print chars_count at the top left side of the text area
5. if chars_count > 140 then:

store text area text in var txt

trim txt from 0 to 139

write txt to text area

wait for text change

6. go to step 3
7. end

Server

1. Read the client response

2. Store the note body in var text.

3. if text length is greater than 140 chars then:

trim text from 0 to 139

4. store txt in db

5. end

4.2.4.3. M2NT Application Interface

An example of editing the note screenshot was presented as shown in Figure 4-7.

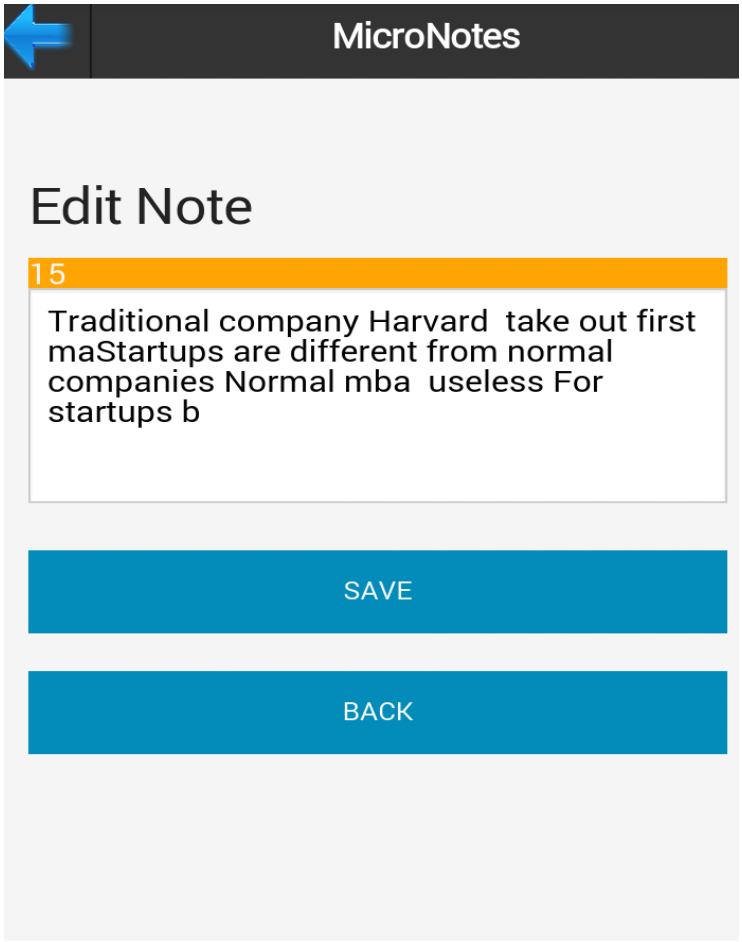


Figure 4-5: The M2NT GUI for editing

The above Figure 4-5 shows the edit micro note. It concerns editing the micro note after typing, where the student can easily edit and change the micro note. There are two options on the page: save and back. Save is used when the student is finished with editing the micro notes and needs to save the changes, whereas the back option is where student can go back to the home note page with no changes made to the micro note. Note the character counter on the top of the text area, where the students are allowed to type the micro notes. This decreases from 140 to 83 according to the number of letters typed for this note.

Another example of a screenshot for the application, viewed on an Android smartphone, can be found in Annex III. Further details of the application code are also shown in Annex III.

4.2.5. Testing the M2NT Application

A pilot study was conducted by a group of PhD students from different departments at the University of Warwick. Moreover, 20 participants were contacted and invited via email to voluntarily participate in the research pilot study. Additionally, the purpose of pilot study was to ensure the functionality of the M2NT and to identify any issues before conducting the main research experiment. Further details of the **procedure** followed to conduct the pilot study can be found later in Section 5.2.

The developed M2NT application was tested during the pilot study by 15 PhD students who responded to the email and volunteered to participate in the pilot study. In addition, the pilot study followed a recommended range of participants that is between 12 and 30, as stated by Hunt et al. [129]. In this pilot study, the M2NT application was installed and configured by the researcher on the hired mobile phone devices. In addition, the reliability of the developed questionnaires was assessed. Section 5.3 includes further details regarding the design of the **questionnaire**.

However, in using the application, a problem appeared with the phone features. The participants had an issue with one of the smartphone features. The participants found that the auto correction feature was not helpful to use in a limited time, because they had to check the words they typed again, as the auto correction sometimes gave another word. Therefore, the researcher had to change the feature mode on the phone to make it more efficient for use during the evaluation experiment. Accordingly, a little work was carried out to disable this feature, based on the participants' suggestion. The application was thus ready to use in the main experiment (Chapter 5).

Some samples of screenshots taken from the database are presented below in Figure 4-6 and Figure 4-7. The screenshots show the interaction of participants while testing the micro note taking application.

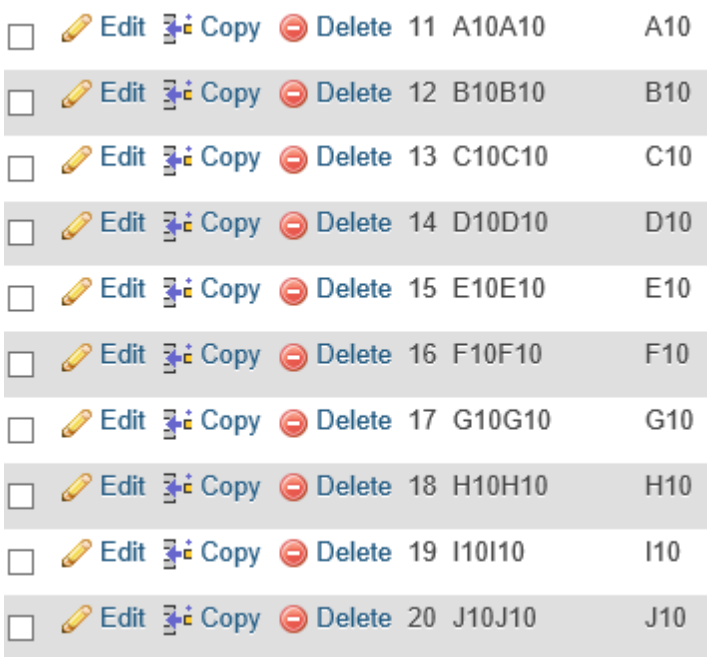


Figure 4-6: Snippet from Database

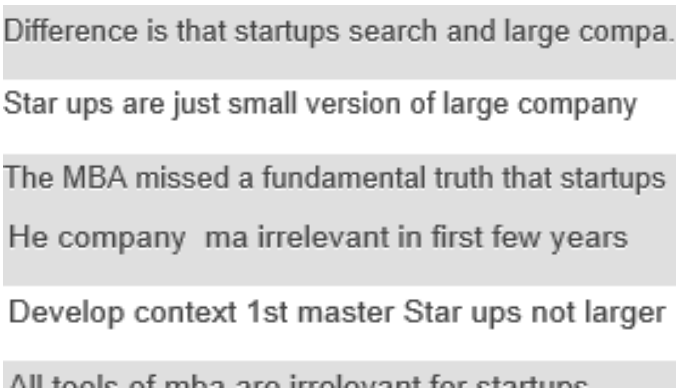


Figure 4-7: Snippet from Database

4.3 Summary

The purpose of this chapter has been to develop the M2NT application with the help of the outcomes of the investigative study. A key underlying aim of the development phase was to determine the application requirements for M2NT application.

Model-View-Control (MVC) pattern design is one of the most frequently used architectures for interactive web based systems. It was utilised to build the application architecture. The waterfall model worked as guidance for the development process of the micro note taking application. The implementation of the application and its details were described. The micro note taking application was tested amongst fifteen PhD candidates, prior the evaluation experiment. The details of the evaluation experiment and its results may be found later in chapters 5 and 6.

This chapter presented the development of the M2NT application for educational purpose based on Web 2.0 and mobile technology. The developed M2NT application was used to formulate a stand-alone web-based mobile application. This application was built on the microblogging feature of short content creation to take notes on mobile devices in the classroom.

The next chapter focuses on conducting the main research experiment. As will be seen, the different data collection methods aim to support the evaluation of students' experience, using M2NT to achieve the aim of this thesis.

Chapter 5

5 Methodology of the Evaluation

5.1 Introduction

This chapter addresses the third and final phase of the research design, which involves the experimentation and evaluation of the students' experience using a mobile device to take micro notes in the classroom. The evaluation was conducted with the help of the developed M2NT application (Chapter 4). This was achieved through research **OB4** which contributed to the answering research questions **RQ2** and **RQ3**.

The experimental study was carried out to explore the effect of M2NT in terms of students' experience and perceived usefulness. The experimental study was thus utilised to determine the differences between three note taking approaches out of many possibilities: traditional pen and paper, the M2NT application and an electronic word processor (e.g. MS Word) as well as understanding the implications of using M2NT as a note taking approach.

Various research methods were adopted in this chapter to conduct an experimental study, in order to evaluate students' perceived experience and their perceived usefulness of using M2NT.

5.2 The Evaluation Approaches

The evaluation of the proposed approach (M2NT) was carried out via a single experiment. The nature of this research was more qualitative than quantitative in nature. However, the questionnaire was analysed as it relates to RQ2, covering the aspect of usefulness, which reflects the user experience. Conversely, the user experience is discussed in more detail as a qualitative approach, as it relates to RQ3 when discussing students' notes, the qualitative comments reported at the end of the questionnaire and focus groups

discussions. Further details of the analysis of the data collected via the evaluation can be found later in the chapter.

The current research and experiment conducted within this chapter aimed to answer research questions **RQ2** and **RQ3,** as introduced below.

RQ2: What is the students' perceived experience and usefulness in using a mobile micro note taking application in comparison to traditional pen and paper and electronic word processor?

This research question is quite rich, as there are three approaches that are compared in terms of note taking activity from the students' experience. This question explores the differences between the three approaches, namely traditional pen-paper, M2NT application and electronic word processor in terms of usefulness (practice). It also investigates the usefulness of M2NT in comparison with the approaches of traditional pen-paper and electronic word processor for note taking.

Another research question to be discussed is **RQ3**: How does using a mobile micro note taking application affect students' perceived experience and perceived usefulness practice?

This research question is investigated in depth when discussing the data collected from students' notes and the open-ended question added to the questionnaire and focus group discussions. It provides an understanding of the implications of M2NT when note taking.

The following section explains the experiment conducted within this research in (further) detail.

5.2.1. Experiment

5.2.1.1. Participants

The experiment was conducted with the help of 21 participants from the Cyber Security course, as well as with the help of 21 participants from the Innovation course. These courses were chosen as the researcher had easy access that facilitated conducting the experiment. The total sample was 42. Participants were (studying) at taught postgraduate level at the University of Warwick. The participation was voluntary.

The only common thing among the sample was that they were part of a community of interest, insofar as they were doing postgraduate courses in the related fields of Innovation and Cyber Security. The postgraduate students were expected to have had enough experience and exposure to new IT-based note taking tools to convey many different responses during the experiments.

5.2.1.2. Design

The evaluation throughout this research for M2NT was conducted based on a repeated measures ANOVA experiment**.** Repeated measure experiments are considered one of the simple experimental design methods. In their simplest form, all the participants are examined using the same note taking approaches [130]. In the experiment the total sample of 42 students was divided randomly into three groups, consisting of 14 participants each. The groups were randomly assigned to use traditional pen and paper, an M2NT application and an electronic word processor so that their experience of using these different approaches could be evaluated and compared. The reason for conducting the experiment this way was to test the differences between the three note taking approaches in terms of students' perceived usefulness. Further, it aimed to ensure that all the students could achieve a fair comparison between the proposed M2NT application and other existing approaches, as well as to support the investigation of students' experience on the effect of the new application and to keep the same students exposed to the different approaches over the specified experiment time. A further description of the

approaches applied in this study may be found in Section 5.2.3. The use of these approaches also places emphasis on the effect of the proposed M2NT: that is, it specifically focuses on the short content creation feature of microblogging technology. It should be noted that these approaches included the smartphone devices given to the students that had been prepared earlier with M2NT to conduct the experiment with minimum effort. A further description of the experiment design is shown below in Table 5-1.

The experiment used a video of 30 minutes (e.g. [107]; [108]); the video covered the topic of the participants' study, and was divided into three sections to be run during the experiment, while using different note taking approaches, as shown in Table 5-1. The main reason for conducting the experiment in the simulated class environment was to avoid disrupting the real class.

Table 5-1: Experimental research design-repeated measure within this thesis

Participants	***Section 1 (10 min)***	***Section 2 (10 min)***	***Section 3 (10min)***
Group (1)	Traditional Pen-Paper Questionnaire A	M2NT Application Questionnaire B	Electronic Word Processor Questionnaire C
Group (2)	Electronic Word Processor Questionnaire C	Traditional Pen-paper Questionnaire A	M2NT Application Questionnaire B
Group (3)	M2NT Application Questionnaire B	Electronic Word Processor Questionnaire C	Traditional Pen-Paper Questionnaire A
All Groups	Final Comparison Questionnaire D		

5.2.1.3. The Advantages and Disadvantages of Repeated Measure Experiment Design

The main benefits of using the repeated measure experiment may be summarised as follows [130]:

1. It helps control the variability between participants' experience across all the note taking approaches, because it has more statistical power;
2. It helps conduct the experiment with a small sample size of fewer participants, in quick time, and at no additional cost;
3. It helps to assess the experience of same participants with three note taking approaches in one experiment.

However, there are some challenges in using repeated measure design; some of these challenges are as follows [131][132].

One of the disadvantages is the order effect. Within this experiment, the effect of a traditional pen-paper, proposed M2NT application and electronic word processor on note taking experience among students was assessed statistically. Students were randomly assigned to three groups, each having 14 participants. The three note taking approaches, traditional pen and paper, M2NT application and electronic word processor were also randomly assigned to fourteen participants within a group of 42 participants.

This was done to ensure randomness and to control the Hawthorne effect (a participant's performance on one task may be affected by the experience of having performed another task, particularly when the two tasks are attempted in close succession). This is also commonly known as the order effect.

The next section introduces the note taking approaches applied within this thesis.

5.2.1.4. Note Taking Approaches

The note taking approaches used during the experiment may be summarised as follows.

1. **Traditional Pen and Paper** is a well-established, traditional means of taking notes in the classroom. It offers room for users to write notes of any length, create tables, draw diagrams or images and mind maps. It has been a common approach across students for note taking until now, where the students come to university powered up with

technological tools; for this reason it was chosen to be used as one approach throughout this thesis.

2. **Electronic Word Processor** is electronic graphical word processing used for many purposes. It allows users to type onto a blank electronic document on computers, laptops and Tablets. Word processor (e.g. Microsoft Word) is a known program and is made available on PC devices at university as a basic tool used by all the students to type their assignments or other products; for this reason it was one of the approaches relied upon throughout this research.
3. **Mobile Micro Note Taking (M2NT)** in the context of this thesis (i.e. the application itself) is a mobile application where students using an Android smartphone can type micro notes in just 140 characters each. The mobile micro note taking application has been designed for educational purposes. Micro notes in this research may be defined as digital notes in small fragments, which particularly refer to micro-content. The application is implemented and used as an experimentation tool throughout this research to collect data from students to be able to evaluate the students' perceived experience and perceived usefulness practice of M2NT.

Please note: there was no feed from Twitter or use of available note taking applications like Evernote and One Note, as they were not suitable for use in experimental research, for the following reasons. First, these applications would require each student to sign up using their email and password, even if we had been able to convince the participants to enter their personal information. Then, it would have been practically impossible to access the students' notes, because we have no access to these commercial note taking applications' databases. Moreover, as the participation was voluntary, I tried to keep the time the experiment took to a minimum.

The measures adopted within this research for evaluating the students' experience of M2NT are presented in the next section.

5.2.1.5. Evaluation Measures

The main evaluation measures for M2NT application in this thesis are ***user experience*** and ***perceived usefulness*** which can be described as follows:

User experience is defined as "*a momentary, primarily evaluative feeling (good-bad) while interacting with a product or service"* [20, p.2]. The user perspective "*focuses on aspects beyond the functional, on the positive, the experiential and emotional"* [19, p.95].

Perceived usefulness is defined as "*the degree to which a user believes that using the system will enhance his or her performance*" [21]. The usefulness measurement has been added to evaluate the perceived usefulness of using M2NT.

Various views and perspectives of students' experience have been interpreted by different researchers (e.g.[19],[20]). Therefore, to connect learning in a narrower context, the following definition is explored, in order to obtain a clear understanding of the evaluation measures used within this research.

Students' experience: the research focused on students' experience, therefore it is the main parameter for evaluation, and in the context of this research, additionally, *perceived usefulness* is also measured, serving as an added measure to students' experience in classrooms. Although the formal definition of users' experience does not include usefulness, the link between the experience and functionality reflects the overall comprehensive experience of the users [19].

In the context of this thesis, the perceived users' experience is measured based on evaluating the experience of students of using M2NT, via a self-created questionnaire (Annex IV, Questionnaire A-D). The reason for creating a new questionnaire was one of convenience, as well as aiming to keep the questions simple for the users, to keep the experiments short. The questions were aimed to capture the current experience of students with the M2NT tool, as well as to capture their understanding of the general M2NT approach, including future application developments. The work within this thesis is

thus focused on students' experience in classrooms environment using M2NT, which was extended to be measured via *perceived usefulness*.

5.2.1.6. Procedure

The experiment was conducted at the University of Warwick and took place on one day, and lasted for less than two hours.

The experiment was deployed as follows: it initially began with the presence of the main researcher who divided the participants randomly into three groups. These groups used the same three note taking approaches during the three sections of the video (see Table 5-1).

The researcher engaged the participants in an introduction to the research aim and purpose of this study, as well as guiding them through the experiment process. She also made the research purpose clear to the students by explaining the proposed M2NT application to take notes in just 140 characters, which is short and brief. Students were provided with an app sheet guidance on how to use the application, and this app sheet guidance can be found in Annex III. The students were also provided with pen-paper and word processor on PCs. A consent form was signed; the BSREC consent and approval letter can be found in Annex I. The students were asked to use the approaches provided to take notes while viewing the video, as described previously in Table 5-1

After each section, students were requested to fill in the questionnaire, in order to evaluate their experience about the actual activities of M2NT and other approaches they performed during the experiment. Due to time limitation, students were requested to share their thinking of what could be their experience about the future use of M2NT and other approaches, regarding the activities they didn't perform during the experiment (see Annex iV, Questionnaire A, B, C, D). For instance, they were asked "….helped me to access the notes at anytime any place while studying", "…..useful for exam revision", "….easy to access the notes for study", "….helped me to manage the notes easily", "…. easy to use".

It is worth noting that the questionnaires focused on aspects of usefulness of the approaches.

Furthermore, the M2NT application is quite a simple approach, with basic features. In order to make the students aware of the application functions and provide answers via the questionnaires to reflect their experience, the students were allowed, during the period of introduction of the application, to explore the functionality of the application with the guidance of the researcher. Before the start of each section - the video - the students were asked if the application functions were clear, or if they needed more clarification. No questions were received during the experiment as regards M2NT approach. There were another two approaches that were used by students (these were: word processor on PCs or traditional pen and paper). The students were already familiar with the ordinary approaches being used for note taking. Therefore, no questions regarding their usage were received throughout the experiment.

Furthermore, the students' micro notes that were taken via the application were used to understand the implications of the notes produced through M2NT. The comments reported at the end of the final questionnaire were used to understand the positive features and negative features regarding the implications of using M2NT. These features were used to elaborate further the challenges and benefits that students faced while interacting with the application for note taking. Further, post focus group discussions were conducted at the end of the experiment to extend understanding of the implications of using M2NT.

The next section will discuss in detail the analysis of the data collected through the procedure introduced above.

5.3 Analysis

There were various data items collected from the conducted experiment within this research which aimed to evaluate the effect of M2NT in terms of students' perceived experience and perceived usefulness. These items were as follows:

1. Questionnaires;
2. Students' notes taken via M2NT;
3. Post focus groups discussions.

Moreover, the data generated throughout the questionnaires was quantitatively analysed to address **RQ2**. The quantitative approach focused on evaluating the students' perceived usefulness of M2NT. In addition, other data collected from the main experiment aimed to achieve an understanding of the implications of M2NT implications in relation to experience which cannot be quantified [138]; this aimed at addressing **RQ3**.

The following subsections explore these data items in detail that gathered from the experimental study.

5.3.1. Analysis of Data from Questionnaires and Open-ended Questions

The responses to the questionnaires were collected from the total sample of 42 who participated in the experiment mentioned above, as shown previously in Table 5-1. The participants were asked to fill in all the four questionnaires. These questionnaires may be summarised as follows.

Table 5-2 Questionnaires used with main experiment

Questionnaires	Note Taking Approaches used within the experiment
Questionnaire A	It was distributed to the participants after using traditional pen-paper.
Questionnaire B	It was distributed to the participants after using micro note taking application.
Questionnaire C	It was distributed to the participants after using electronic word processor.
Questionnaire D	It was distributed to the participants at the end of the whole experiment after experiencing the three note taking approaches and filling in the questionnaire related to each approach.

Thus, the questionnaires (A, B, C and D) developed and distributed aimed at answering **RQ2,** as introduced above.

The questionnaires (A, B, C and D) were paper-based. A 5-Likert scale questionnaire was developed for this study. Each questionnaire item had a number of statements ranging from 1 strongly disagree to 5 strongly agree. The main objective of using the Likert scale was to help the researcher to understand the students' preferences and degree of agreement with statements [135]. The scale's invention is attributed to Likert [143], who established this technique to assess attitudes. This scale can more conveniently show the range of 168 responses, from a strong positive one to a strong negative one, with the mid-point indicating a neutral response. In addition, Hair et al. [135] hold the view that the Likert scale is one of the most useful devices available, as it builds in a degree of sensitivity and differentiation of responses. Moreover, Likert scales are the most frequently used scales in IT/IS research [144]. It is worth noting that data gathered from the questionnaires reflected the experience of students after interacting with the application and other approaches.

The questionnaires (A, B and C) consisted of 9 items covering aspects of usefulness for each of the three approaches. The same items were used in the three questionnaires. The aim of these questionnaires was to determine the differences between the three note taking approaches in terms of students' perceived usefulness.

Moreover, the final questionnaire (D) included a total of eight statements that focused on the comparison between the three note taking approaches. The final questionnaire aimed to compare the usefulness of M2NT, traditional pen-paper and electronic word processor note taking from the perspectives of the students. The questions that were used to compare M2NT and other approaches were slightly different from the other set of questions used for questionnaires (A, B and C). In addition, two open-ended questions were added at the end of this questionnaire. These open-ended questions asked the participants to express their experience about the positive and negative features of M2NT when note taking. The following questions were asked:

- What are the ***positive*** features of using the micro note taking application?
- What are the ***negative*** features of using the micro note taking application?

Please note that the responses gathered via the questionnaires (A, B and C) represent the differences between the three different approaches in regards to perceived usefulness. The other set of final questions (D) represents the perceived usefulness of M2NT in comparison to the traditional pen-paper and electronic word processor approaches.

The pilot study was conducted on the questionnaires with the help of fifteen PhD candidates at University of Warwick. The PhD group used the application and filled in the questionnaires before the main experiment, as mentioned in Section 4.2.5. Based on their suggestions, the instruments were improved in terms of wording. The reliability of the questionnaires was assessed using *Cronbach's alpha* to exhibit the internal consistency [163]. The questionnaires were then ready to be used in the main evaluation experiment.

The reliability of the results are presented in Annex V. The questionnaires: questionnaire A, questionnaire B, questionnaire C and questionnaire D can be found in Annex IV.

To choose the analysis techniques that need to be applied on the data collected from the questionnaires, a normality test was also used. A prerequisite for using parametric tests is to see if the assumption of normality is met i.e. whether the data follows normal distribution or not. Details of the results for normality distribution can be found in Annex V.

As the data fits normal distribution, various parametric statistical tests have been employed in this study. The sample size used in this study was small, and therefore it seemed that statistical tests are appropriate to apply to the small sample size[145]. These tests can be described below:

1. F-test (ANOVA);
2. Post hoc test;
3. T-test.

ANOVA repeated measure is a parametric test employed in this research. It was used to test between groups for statistical differences between the three different note taking approaches on perceived usefulness [130]. It was applied to the data received from questionnaire (A, B and C). The job of ANOVA was to tell whether there was at least one mean significant difference from one other mean [130]. Since ANOVA is an omnibus test, a follow up post hoc test was therefore carried out. The test function of post hoc was to tell which means were significantly different from each other. The Bonferroni method is statistical tool that was chosen to carry out post hoc analysis. Bonferroni method was used for multiple comparisons [146].

Furthermore, a T-test is another parametric test of statistical significance. T-test was used in this study to determine whether there are statistical differences between the students' experiences using a proposed micro note taking application, compared to traditional pen-

paper and electronic word processor. It was utilised for the data retrieved through the questionnaire (D).

The quantitative findings for the questionnaires mentioned above are discussed in detail in Chapter 6, Section 6.2.1.

A content analysis approach on student feedback was also used to better understanding the findings of the implications of M2NT through the students' micro notes. Out of 42 participants, only 25 in the open ended questions at the end of the questionnaire expressed their experience of using the proposed application. The main objective of the analysis was to transform data into findings, but more importantly to make sense of it [13]. The outcomes of this analysis aimed to address **RQ3**. During the analysis, as lists of ideas emerged, ideas were grouped based on significant headings to form the concepts. Next, related concepts were aggregated into categories to form the themes that constituted the results of this research. The emerging themes were then examined based on their intensity, depth, and specificity with the research question, with additional emphasis given to comments that were frequently repeated or refuted by the participants. Each theme was then given a weight. The weight was calculated as follows: the number of either positive comments or negative comments in each theme divided by the number of participant who left feedback on the last part of the questionnaire multiplied by 100%. The outcomes of students' comments at the end of the survey are discussed in Chapter 6, Section 6.2.2.

5.3.2. Analysis of Students' Notes Taken via M2NT Application

Students' micro notes taken via the micro note taking application were collected from the database at the end of the experiment from the total sample of 42 students. The outcomes of these micro notes aimed at addressing the research question **RQ3**. This question aimed at investigating the influence of the short content creation feature of microblogging for note taking activity on students' experience. The target was to understand the implications of M2NT on the micro notes produced using the application. Please note that

the data focused on the perceived usefulness aspect has been covered and investigated in detail in the previous sub-section 5.3.1.

The micro notes were used to gain a further understanding of the implications of M2NT via the notes generated by the students. On the micro notes, we looked at the following aspects:

- the total number of micro notes;
- the total length of micro notes;
- the usefulness of the micro notes generated.

The methodology of micro notes analysis was developed using previous research conducted for notes analyses (e.g. [57][115][118]). The micro notes collected from the experiment were compared with a list of main ideas produced by a university lecturer. The list of main ideas was extracted by the lecturer from the video transcript, which was expected to be present in the students' notes. This list of main ideas was used to compare with the generative micro notes that were produced using the application in terms of whether or not they represented useful notes.

The group of four PhD candidates from the department where the experiment took place were contacted via email to examine the collected micro notes. The choice of PhD candidates was made because they taught the same students who the experiment was conducted with, and were consequently easy to access. Moreover, they were more familiar with the content of the material presented in the experiment. They were also selected because of the difficulties in accessing other participants, especially members of teaching staff at the department. One PhD candidate accepted the invitation that was sent by the researcher. The findings on the students' micro notes are discussed in Chapter 6, Section 6.2.2.

5.3.3. Analysis of Post Focus Group Discussions

The two focus groups were conducted at the end of the experiment with 14 participants (8 females and 6 males). All the participants used micro note taking in the experiment described above. Data from these focus groups using semi-structured methods were collected. This qualitative data included points that were not directly addressed in the questionnaires. The aim of conducting these focus groups was to enhance the understanding of the user experience using the micro note taking application as a technological approach to support note taking activity in the classroom.

The focus group discussions aimed to extend an understanding of what university-level students' experiences are, in terms of note taking by using just 140 characters on Android smart phones. Moreover, the discussions aimed to elaborate on what and why the preferences of using this new format of notes were in an educational environment for note taking activity, and how this application could be improved to support students' note taking activity in a classroom. To gain insight into these concerns, the results generated from the focus group experiments are discussed Chapter 6, Section 6.2.3. These results were achieved as part of the discussions with the students who took part in the experiment, in particular their experience while using the micro note taking application for note taking.

The focus group questions were open ended, and related to the use of the micro note taking application in the experiment. The discussion was kept focused around the proposed micro note taking application for note taking activity. The findings aimed at answering the research question **RQ3***.* In order to reach an answer the focus group guide was composed of the following questions.

- What are the positive features of the mobile micro note taking approach? Please explain.
- What are the negative features of the mobile micro note taking approach? Please explain.
- Would you prefer to use 140 characters for writing your notes? And why?

- What are the difficulties you faced when using the mobile micro note taking application in a lecture?
- Do you think that other students would find the application appealing, and why?
- What other features would you recommend to add to the mobile micro note taking application?

Discussion was centred on these areas in order to ensure coverage of only key areas that were closely related to, or relevant to the study.

The transcribed audio data was aggregated with the moderator's notes. The qualitative outcomes which were generated from these focus groups were analysed using content analysis [134]. The content analysis method "*is a technique that enables researchers to study human behaviour in an indirect way, through an analysis of their communication"* [134, p.478]. This method shows three different approaches: conventional, directed or summative [139]. The approach to be used is conventional, as it focuses on coding schemes that are directly derived from the text data transcribed from the focus group discussions. The combined content was qualitatively analysed by looking for concepts in the responses and categorising these concepts into themes [140]. The focus group was conducted to help the researcher gain further understanding of the students' experience due to use of micro note taking [141].

5.4 Summary

The focus of Chapter five was evaluating the students' experience in the classroom environment, using three note taking approaches: pen and paper, electronic document application and M2NT. This covers the evaluation phase, which is the final phase of the research design

The conducted experiment presented within this chapter aimed at addressing the research sub questions **RQ2** and **RQ3**. The research questions were addressed via an

evaluation that produced three different types of data item: questionnaires, focus group and micro notes analysis. The overall data collections contribute to answering the main research question: How does short content creation on a mobile application influence students' perceived experience?

The evaluation was carried out in regards to one experiment; the experiment was conducted with the help of 42 participants. The main aim of the evaluation was to examine how the developed approach of mobile micro note taking using the 140-character feature supports the practice of note taking in relation to the students' experience. Students' experience in this research was extended to include usefulness as a connected measure of evaluation that suggests a comprehensive outcome.

The three data items collected from the experiment were: questionnaires, the students' notes taken via M2NT application, focus groups and other qualitative feedback. The data was a mixture of quantitative and qualitative. The quantitative data was investigated extensively and in depth, in order to establish a conclusive and well-connected finding of the experiments. The experiment quantitative data focused on the usefulness of the M2NT approach and covered aspects of **RQ2,** whereas other data focused on the experience when note taking using M2NT addressed **RQ3**. For example: the notes produced via the application were used to describe the implications of the M2NT application on the produced students' notes. The comments reported via the end of the questionnaire on the application were used to elaborate on the outcomes of the notes produced via M2NT. The comments explained the positive and negative features that students faced when using the M2NT application. The focus group qualitative discussions were used to extend the understanding of M2NT implications when note taking.

The following chapter discusses the results of the evaluation of this study. This will include the results gathered from the main experiment, which reflect the students' experience as well as perceived usefulness practice of M2NT.

Chapter 6

6 Results and Discussions

6.1 Introduction

In the previous chapter, an experimental study was conducted to evaluate students' experience using M2NT. This was achieved through a number of questionnaires that were collected from a total sample of 42 postgraduate students from the University of Warwick. The questionnaire conducted resulted in a total of 126 responses that were obtained in relation to the experimentation of three note taking approaches (i.e. traditional pen-paper, M2NT application and electronic Word processor). Further, another 42 responses were received in regards to the comparison of M2NT with the other two note taking approaches (i.e. traditional pen-paper and electronic word processor).

Moreover, additional data was gathered from the experiment: students' micro notes taken and students' feedback comments. Micro notes were taken by a total sample of 42 students using the M2NT application and in addition to feedback comments reported at the end of the survey. The comments were obtained from 25 out of 42 participants that expressed the positive and negative features of M2NT. Finally, post discussions of focus groups by 14 students after the experiment were conducted.

This chapter aims to meet research objective **OB5** which contributes to answering research questions RQ2 and RQ3. Therefore, the results gathered are evaluated and the quantitative findings are discussed in detail. In addition, the findings on students' micro notes followed by the outcomes of positive and negative features of M2NT are also presented. Finally, the findings on the post focus groups are discussed, and a conclusion is presented to wrap up the main findings of this research.

6.2 Discussion on the Findings of Questionnaires

6.2.1. Demographics

The participants in the sample were postgraduate students at the University of Warwick. 35.7% of the students' ages ranged between 22 and 25 years, and 64.3% were above 25. 45.2% were females and 54.8% were males.

Aspects of usefulness in relation to research question **RQ2** have been investigated in depth within this chapter.

The following subsections answer the second research question **RQ2**. The aspects to be investigated concern the perceived usefulness of M2NT. The data in Table 6-1 addresses the differences between the usefulness of the three approaches. Also, the data in Table 6-1 examines the significant differences between the three different approaches on perceived usefulness. Table 6-2 applies follow up post hoc analysis to distinguish between the students' perceived usefulness regarding the three note taking approaches. Table 6-3 addresses the perceived usefulness of M2NT in comparison with the ordinary note taking approaches (e.g. traditional pen-paper, electronic word processor).

6.2.2. Comparison between Students' Experience and their Perceived Usefulness Using Traditional Pen and Paper, Mobile Micro Note Taking Application and Electronic Word Processor

Table 6-1: Results for usefulness question RQ2

Statements		**Traditional Pen-Paper**		**Mobile micro note taking**		**Electronic word processor**		**Repeated Measure ANOVA Results**	
		Mean	**Std.**	**Mean**	**Std.**	**Mean**	**Std.**	**F-test**	**Sig.**
#	*N=42*								
1	The NT approach helped me to capture notes quickly	2.93	0.89	3.52	0.89	3.31	1.35	F(2,82)= 3.36	0.03
2	The NT approach helped me to manage the notes easily	2.76	0.93	3.95	1.26	3.48	1.21	F(1.73,82)=10.99	0.00
3	The NT approach offered safe storage for the notes to be used later	2.93	0.92	4.00	1.26	3.43	1.12	F(2,82)= 9.91	0.00
4	The NT approach helped me to capture accurate notes including exact points mentioned in a lecture	2.79	1.15	4.00	1.14	3.07	1.21	F(1.95,79.99)=13.59	0.00
5	The NT approach helped me to capture complete notes and include everything I need for studying	2.93	1.09	3.86	1.26	2.79	1.18	F(1.97,80.77)=11.23	0.00
6	The NT approach helped me to remember the lecture easily in study time	3.14	0.64	3.29	1.07	3.14	1.31	F(1.98,81.50)=10.23	0.00

7	It was easy to read the notes for later study	2.81	0.80	3.64	1.30	3.00	1.08	F(2,82)= 7.13	0.00
8	It was easy to access the notes for study	3.29	0.91	4.14	1.20	3.24	1.00	F(1.76,72.2)=9.21	0.00
9	The approach helped me to find relevant notes to my questions while studying	2.98	0.97	3.57	1.12	3.26	1.14	F(1.94,79.4)=3.07	0.04
Overall *usefulness*		**2.95**	**0.92**	**3.77**	**1.17**	**3.19**	**1.16**	**-**	**0.00**

RQ2 addressed various aspects of usefulness in relation to mobile application micro note taking practice. From the table above, the application was found to be mostly successful as an easy to access way for the notes to be collected. All other features related using the application such as managing notes, safe storage of notes, and accurate collection of notes and completeness of notes affected note taking practice using mobile applications, with the following mean values 3.95, 4.00, 4.00 and 3.86 respectively. Despite the fact that all of the results are considered positive as all the mean values are higher than three, other features were not as successful as the one previously mentioned. These features include the speed of note capturing, the ease of remembering and reading the notes, as well as finding the relevant notes on revision time. The mean values of these items are 3.52, 3.29, 3.64 and 3.57 respectively.

The overall usefulness of the M2NT application is positive, and all the features mentioned above are considered relevant, with a positive mean value of 3.77 indicating a positive experience.

For students' perceived usefulness of traditional pen-paper results*,* the overall *mean* for students' perceived usefulness is 2.95, with the lowest and highest means for features being 2.76 and 3.29 respectively. As the means for students' perceived usefulness of traditional pen-paper were clustered around 3 (the neutral response), the overall

perceived usefulness of traditional pen-paper was neutral i.e. the students were not very satisfied, but at the same time they were not dissatisfied with this approach. Another outcome from the questionnaire is that the highest value *mean* of perceived usefulness of pen-paper for accessing students' notes is 3.29. However, the lowest value *mean* of perceived usefulness of pen-paper for managing the notes is 2.76, indicating that the notes taken through the use of the traditional approach can be easily accessed but managing the notes for useful review later might be difficult using pen-paper.

For *students' perceived usefulness of mobile micro note taking (M2NT) application* results*,* the *mean* for perceived usefulness was 3.77 with the lowest and highest means for features being 3.29 and 4.14 respectively. As the means for perceived usefulness of mobile micro note taking application were all greater than 3 (the neutral response), it is inferred that most of the students found that using the M2NT application for note taking can be relatively helpful in capturing notes quickly, was easy to manage, safe to store, accurate in terms of capturing the key points, helpful in capturing complete notes, was easy regarding remembering the information for later use, was easy to read for later use, easy to access the notes for later use and easy to find the relevant notes to the questions in study time.

For *students' perceived usefulness of electronic word processor* results*,* the *means* for perceived usefulness is 3.19 with the lowest and highest means for features being 2.79 and 3.48 respectively. The overall means for perceived usefulness of electronic word processor were all greater than 3 (the neutral response). Additionally, the highest *mean* value for perceived usefulness of electronic word processor to manage the notes was 3.48. However, the lowest *mean* value for perceived usefulness for managing the notes was 2.79, suggesting students' perceived usefulness of the electronic note taking approach to be generally positive.

The overall usefulness of mean values are 2.95, 3.77 and 3.19, indicating the highest overall mean for the micro note taking application.

The analyses of the data above indicates that there is a difference between students' perceived usefulness regarding the three note taking approaches evaluated. The students overall perceived usefulness with the traditional approach cannot be conclusive, because their overall perception was neutral. The overall students' perceived usefulness of mobile micro note taking application is positive and the trend of the means indicate a somewhat positive tendency regarding the perceived usefulness of word processor, but still cluster around the neutral response of 3.

Question RQ2 also investigated the significant difference between the perceived usefulness of three note taking approaches and the degree to which this exists or not (these are traditional pen-paper, M2NT application and electronic word processor). Two parametric statistical tests were applied; these two significant parametric tests, which are a repeated measure ANOVA and post hoc test, were conducted. Further details about the significant test performed are discussed in Chapter 5, Section 5.3.1.

The Repeated Measures ANOVA was repeated 9 times to compare the results of 9 statements on the three note taking approaches. As witnessed from Table 6-1, in making a comparison of means of students' perceived usefulness of the three note taking approaches across all the 9 statements, the p-value (sig.) is less than 0.05 level of significance. This indicates that there is a significant difference between the students' perceived usefulness regarding the three note taking approaches.

The perceived usefulness did differ depending on whether the method of note taking was traditional pen-paper, mobile micro note taking (M2NT) application or electronic word processor, as each approach had a distinguishable perceived usefulness effect on learners. These findings confirm the positive feedback of learners through the use of the micro note taking application, as well as their neutral perceptions of using the other approaches.

The M2NT application related to perceived usefulness has been found to be mostly positive, as discussed above. The M2NT application has also indicated a significant

difference in all features in comparison to traditional note taking approach and word processor. Further discussion of these differences is provided next.

6.2.3. Comparison between Students' Experience and their Perceived Usefulness Using a Mobile Micro Note Taking and Traditional Pen and Paper and Comparison between Students' Experience and their Perceived Usefulness Using a Mobile Micro Note Taking and Electronic Word Processor

In order to assess whether significant differences in usefulness exist amongst the three note taking approaches, omnibus ANOVA was applied (Please refer to Table 6-1). As a result of the ANOVA test, which indicated a significant perceived usefulness difference between the approaches, a follow up analysis is needed to study how usefulnesses differs from traditional pen-paper and electronic word processor.

Since significant differences in the perceived usefulness between the three note taking approaches exist. The Bonferroni method is the statistical tool that was chosen to carry out post hoc analysis [146]. *P*-value of less than 0.05 was defined as statistically significant. Further details on the test performed may be found in Chapter 5, Section 5.3.1.

The results are abridged (summarised) in Table 6-2 to compare perceived usefulness using micro note taking and other existing approaches (namely traditional pen-paper and electronic word processor).

Table 6-2: Pairwise comparison results RQ2

Statements		*M2NT Application vs. traditional pen-paper*			*M2NT Application vs. electronic word processor*		
		Mean Differences	**Std.**	**sig.**	**Mean Differences**	**Std.**	**sig.**
N=42							
1	The NT approach helped me to capture notes quickly	.59*	.19	.01	.21	.24	1.00
2	The NT approach helped me to manage the notes easily	1.19*	.20	.00	.47	.29	.32
3	The NT approach offered safe storage for the notes to be used later	1.07*	.24	.00	.57	.25	.08
4	The NT approach helped me to capture accurate notes including exact points mentioned in a lecture	1.21*	.22	.00	.92*	.25	.00
5	The NT approach helped me to capture complete notes and include everything I need for studying	.92*	.24	.00	1.07*	.25	.00
6	The NT approach helped me to remember the lecture easily in study time	.83*	.20	.00	.83*	.22	.00
7	It was easy to read the notes for later study	.83*	.20	.00	.64	.28	.08
8	It was easy to access the notes for study	.85*	.20	.00	.90*	.27	.00
9	The approach helped me to find relevant notes to my questions while studying	.59*	.22	.03	.31	.26	.72

The results from the table above indicate which students' perceived usefulness of the three different note taking approaches differed from the others. The results reflect the fact that students perceived mobile micro note taking as being more useful than either traditional pen-paper or some features related to electronic word processors.

The results in Table 6-2 present post-hoc analysis pairwise comparisons for the set of questions. The questions were the same ones used in previous analysis (please refer to Table 6-1). The questions addressed usefulness in relation to micro note taking vs. traditional pen-paper and mobile micro note taking vs. electronic word processor. The analysis displays the mean differences under the three note taking approaches on students' perceived usefulness. This is discussed in Table 6-2:

For students' perceived usefulness of *mobile micro note taking* vs. *traditional pen-paper* results, the *means* difference for students' perceived usefulness for capturing the notes, managing the notes, offering safe storage, capturing accurate notes, capturing complete notes, remembering the notes, reading the notes, easy accessibility and finding relevant notes by using micro note taking, rather than traditional pen-paper, indicate that micro note taking is more useful than traditional pen-paper for note taking from students' perspectives. This is because the significance level of micro note taking vs. traditional pen-paper is less than the predetermined significance level. This is a clear indication that in relation to RQ2, the M2NT application has a significant difference of perceived usefulness compared to the traditional approach of note taking. These results place clear emphasis on the design and implementation of users' requirements that led to these positive outcomes in comparison to traditional approach of pen and paper.

Furthermore, for students' perceived usefulness of *micro note taking* vs. *electronic word processor* results, the *means* difference for students' perceived usefulness for capturing notes, capturing accurate notes, capturing complete notes, remembering the notes and easy accessibility using micro note taking rather than electronic word processor, suggest that mobile micro note taking is more useful than electronic word processor for note taking

from students' perspectives. The reason behind this is that the significance level of micro note taking vs. traditional pen-paper is less than the predetermined significance level.

However, for students' perceived usefulness of *mobile micro note taking* vs. *electronic word processor* results, the *means* difference for learners' perceived usefulness for managing the notes, offering safe storage, reading the notes and finding the relevant notes through using micro note taking rather than electronic word processor, highlighting that the learners' perceived usefulness of micro note taking and electronic word processor do not differ much when using both approaches. This is because the significance level of micro note taking vs. electronic word processor is greater than the predetermined significance level.

Overall, the outcomes from the table above call to attention the fact that students were more positive about using the M2NT application for note taking activity than they were traditional pen-paper. This is achieved as long as the electronic word processor is limited to the M2NT application within these four areas namely; capturing accuracy of the notes including exact points mentioned, capturing the completeness of the notes a student needs, remembering the lecture in study time, and easy accessibility of the notes. This indicates that the usefulness of the mobile micro note taking application supports students' note taking activity to a greater extent than does a traditional pen-paper approach or an electronic word processor in the previously mentioned areas. In general, the study suggests that students' perceived usefulness of M2NT applications is that it is an improved approach. Thus, it is clear that based on the generated results, the experience of students were positive and perceived as more useful in using the M2NT application.

6.2.4. Comparison between Students' Experience and their Perceived Usefulness Using a Mobile Micro Note Taking than Traditional Pen-Paper and Electronic Word Processor

The last aspect in relation to RQ2 is to examine if the micro note taking approach is more useful than the other two approaches. This requires a follow up analysis that addresses the general students' experience regarding the usefulness of mobile micro note taking in comparison with other approaches. It compares the students' perceived usefulness of mobile micro note taking over either traditional pen-paper or the electronic word processor. Table 6-3 addresses the usefulness of mobile micro note taking over other approaches.

In order to address this aspect, another final set of questionnaire was conducted to compare the M2NT application with the approaches of pen-paper and electronic word processor.

Table 6-3 is a description of the comparison outcomes generated. The analysis is to measure the usefulness of micro note taking in comparison to the existing approaches from students' perceived experience.

Table 6-3: Results for comparison of usefulness questions for RQ2

Statements		**Mean**	**Std.**	**t-test**
#	***N= 42***			
1	Mobile micro note taking was easier to use compared to traditional/electronic approaches.	3.88	.86	.00
2	Mobile micro note taking offered safe storage for the notes in one place compared to current traditional/electronic approaches.	3.21	.95	.15
3	The 140 characters limit of mobile micro note taking helped me to generate better notes than traditional/electronic approaches.	3.40	1.03	.01
4	The 140 characters limit of mobile micro note taking helped me to not write every word in a lecture than	3.36	.93	.01

	traditional/electronic approaches.			
5	Mobile micro note taking helped me to remember captured information more easier in exam time compared to current traditional/electronic approaches.	3.62	.93	.00
6	Mobile micro note taking was more useful for exam revision compared to current traditional/current approaches.	3.48	.99	.00
7	Mobile micro note taking helped me to access the notes at any time any place while studying compared to current traditional/electronic approaches.	3.55	1.06	.00
8	Mobile micro note taking helped me to review all the notes quickly minutes before the exam compared to current traditional/electronic approaches as they are brief.	3.62	1.22	.00
	Overall Usefulness	**3.51**	**0.99**	**0.02**

Descriptive statistics and inferential statistics were carried out to interpret the data. Further details on the statistical test performed are discussed in Chapter 5, Section 5.3.1.

All the answers above indicate that students expressed positive feedback related to the usefulness of the M2NT application. It also compares the mobile micro note taking (M2NT) application with other note taking approaches in terms of usefulness and reports positive outcomes

To interpret the data, any mean value of larger than 3 is considered positive. For example: the ease of use with the mean value of 3.88 indicated that the students found the use of M2NT application easier than other approaches. The answer to the second item with a mean value of 3.21 shows that the M2NT application offered safe storage for notes compared to other note taking approaches. These results are consistent with Reimer et al. [3], where approximately 25% of respondents involved in their study reported that they had a hard time finding their notes, either traditional notes or electronic notes, when they needed them. In addition most respondents reported that micro note taking was easier to use, easier to access and that it was quicker to retain information with a mean value of 3.88, 3.55 and 3.62, respectively. These finding are consistent with Schepman et al. [166]. The majority of the respondents showed an overwhelming interest in the perceived usefulness of using the application, for example, help not to write every word in a lecture

in contrast to traditional/electronic approaches with mean value of 3.36, help to generate better notes than traditional/electronic approaches with mean value of 3.40 and help to review all the notes quickly minutes before the exam with mean value of 3. Thus it is clear that most of these respondents felt positive about using M2NT for note taking compared to other note taking approaches. In general the usefulness mean value is 3.51. The results are an indication that the use of the short text feature is useful from a user experience perspective.

One parametric test was conducted; the t-test is a statistical test as also given in Table 6-3. All functionalities were statistically significant, with a probability value of 0.00 or less than 0.05, illustrating the significance of the findings. This was except for the feature of safe storage that was not found significant, as the value of 0.15 is larger than the accepted threshold of 0.05, and this might be due to the limited memory capacity of the mobile devices.

The feature of safe storage has been highlighted as not being as positive as other results obtained. This indicates that there is an in-built storage capacity available in both mobile micro note taking and electronic word processor approaches.

Based on the above findings from both the descriptive statistics and significant tests, the experience of students as regards the usefulness of mobile micro note taking (M2NT application) were positive for all the features except for the safe storage feature.

6.3 Discussion on the Findings on the Students' Micro Notes and their Feedback

The outcomes of the micro notes taken during the experiment using M2NT application are presented within this chapter in relation to research question **RQ3**.

The outcomes of micro notes were used to gain further understanding of the implications of the M2NT application via the notes generated through that application.

Table 6-4 illustrates the outcomes in relation to the mobile micro notes analyses. Further details on the analyses of the aspects that were looked at are introduced in Chapter 5, Section 5.3.2. However, they are presented in Table 6-4 as below.

Table 6-4: Results related to micro notes analyses within this thesis

Aspects	Results
Total amount of the micro notes	5.4% micro notes / student
Total length of the micro notes	44.5% words / student
Number of the words for each micro note	8.2 words
Usefulness of the micro notes	37.2%

The results introduced above from the gathered micro notes are based on the sample detailed below.

The total amount of micro notes produced through the application was 228, from 42 learners who used the application. This is a percentage of 5.4 micro notes per student.

The total number of words from the micro notes generated via the application was 1871 words from 42 students. This is a percentage of 44.5 words per student.

The number of words for the micro notes produced per student through the application was 8.2 words from each of 5.4 micro notes. This is a percentage of 44.5 words per micro note.

The last concern regarding the usefulness of micro notes with the help of a PhD candidate (tutor) as discussed in Chapter 5, Section 5.3.2.

Of the 228 micro notes taken via the application, only 85 were labelled by the tutor as representing useful information, which represents a percentage of 37.2%. The outcomes of the tutor's evaluation thus show that he did not find the overall quality of the notes as high. This indeed raises some concern, and will require further analysis, in order to understand the reasons behind it. It may be that choosing to introduce sharing would be able to enhance the level of quality of these notes, for example, by allowing for a higher level of complete notes (if, e.g., students are missing different parts of the information).

The reason why sharing was not introduced at this stage was explained earlier, in section 3.2.2.4. The other reason was in order not to introduce too many variables at the start of the research. Nevertheless, even from the current research, it is possible to better understand this issue from the students' point of view, by analysing the students' comments about M2NT at the end of the survey. Further explanation about the positive features and negative features students faced when note taking using M2NT can be found in Section 6.3.1 and Section 6.3.2.

6.3.1. The Positive Features of M2NT

The **positive** students' feedback on using M2NT when note taking was classified is shown in Table 6-5. The weight was calculated as follows: the number of positive comments in each theme was divided by 25 (the number of participant who left feedback on the last part of the survey) and multiplied by 100%. Further details on the analysis approach can be found in Chapter 5. Section 5.3.1.

Table 6-5: Content analysis of positive comments

Theme	Examples	Weight (%)
Note Taking Empowerment	• improve the ability to take short notes	4%
Effective Note Taking	• think of what you want to write • enable taking the main points in lectures • 140 characters advantage • only take important points with limited words • less disruption	20%

Theme	Examples	Weight (%)
Efficient Note Taking	• speedy way to take notes • only take important points with limited words • fast and short • help writing short and concise notes • limit the habit for note-taking • time saving	24%
The recall of notes and Retrieval Advantage	• good for sub revision • last minute study approach • suitable for self-revision • convenient revision before exam • easy to retrieve • stored in one place	24%
Mobility Advantage	• can read and edit everywhere	4%
Convenience Advantage	• always has a phone in class • light to carry phone into the class • simple • handy • ease to use • stored in one place • easier to read • simple GUI	32%

Note: the total sum of percentages may exceed 100% as some of the comments are categorised in more than one theme.

Based on the content analysis of the positive comments of students at the end of the questionnaire, six main advantages of the micro note taking M2NT application were identified: note taking empowerment, effective note taking, efficient note taking, the recall of notes, and retrieval advantage, mobility advantage, and convenience advantage. Further, the analysis demonstrated that the aforementioned advantages and benefits differ in terms of their weight of importance from the perspective of students. In fact, it was found that student perceive **convenience** to be the most beneficial feature that the micro note taking M2NT application can offer (32% weight of importance). This was clearly demonstrated through the comments of students, as they believe that the developed application is handy, simple, and offers ease of use. The second rank of the benefits of the micro note taking M2NT application was for recall of notes and retrieval advantage, as well as efficient note taking with 24% weight of importance for each. students indicated through their comments within the questionnaire that using a mobile micro note taking M2NT application would help them in retrieving their notes in an easy and simple manner, given that all notes would be stored in one digital place and thus such an approach would be considered convenient as a last minute study approach and also convenient for revision before exams. Effective note taking as an advantage of using the developed mobile micro note taking M2NT application ranked third according to its 20% weight of importance. Indeed, students appreciated the fact that they were able only to take important points with limited words and with less disruption using the developed micro note taking M2NT application. Finally, both note taking empowerment in terms of improving the ability of students in taking notes and mobility advantage in terms of the ability of students to read and edit notes in any location were ranked fourth, with 4% weight of importance each. These results correlate with the quantitative results discussed in the previous section as easy to use, easy to capture, easy to access, better management of notes, safe storage and accurate notes.

6.3.2. The Negative Features of M2NT

The outcomes of the **negative** comments that students reported through the questionnaire data collection instrument are presented below. Accordingly, comments were categorized in the following themes as shown in Table 6-6. The weight was also calculated.

Table 6-6: Content analysis of negative comments

Theme	Examples	Weight (%)
Mobile Device Constraints	• typing errors • slow typing • small screen is not comfortable • hard to type on the small screen • difficult to type on time • quite stressful due to input size on small device against desktop • tiny touch keyboard sometimes annoying • mobile is off can't access the stored notes	32%
Distraction	• on the phone can't focus • hard to focus on the phone	8%
Unfamiliarity	• not familiar with the device type • typing errors • don't get to use the device • first time using the device • slow typing	28%

Theme	Examples	Weight (%)
	• not familiar with texting on the phone • difficult to type on time	
Note-Size Limitation	• sometimes 140 characters is not enough	4%

Based on the content analysis of the negative comments of students at the end of the questionnaire, four main disadvantages of the micro note taking M2NT application were identified: mobile device constraints, distraction, unfamiliarity, and note-size limitation. Further, our analysis demonstrated that the aforementioned disadvantages differ in terms of their weight of importance from the perspective of students. In fact, it was found that learners perceive that mobile device constraints and unfamiliarity are the main disadvantages of the developed micro note taking M2NT application with weights of importance equal to 32% and 28% respectively. Indeed, it was clear from the comments of the learners that they found that the small screen size and tiny touch keyboard stressful. Further, students indicated that their lack of familiarity with the device, application, and mobile-device texting negatively affected their experience. However, another two disadvantages of using the micro note taking M2NT application were demonstrated by the students, these being distraction (8%) and note-size Limitation (4%). The weights of importance of these two disadvantages show their insignificance in comparison to the first two, namely mobile device constraints and unfamiliarity. These results also match the ones obtained earlier and the discussion of why the M2NT application in comparison to word processor can have some less preferred features.

The findings agree with what Al-Musalli [167] highlighted, namely that *good note taking technique can generate good NT practice.* The short content creation feature developed on the mobile note taking application was targeted and evaluated in relation to perceived

students' experience. Overall, the results generated through the notes on the application based on the employment of the short content creation feature indicate the positive experience of students due to the use of M2NT approach for note taking activity.

Generally speaking, the experience of students with the use of the short content creation feature for note taking was positive (see Table 6-*1*). However, two main issues were raised in the qualitative study (see); the usability was considered an issue, and lack of familiarity was mentioned, when using smart phones which were not theirs.

Providing students with prepared smart phones resulted in such issues as lack of usability and low familiarity, as they were not familiar with the device's features and had not been aware of them before the experiment. According to Herrington et al. [168, p.136] "*using a learner's own device ensures that many of the features of the devices are well known and practiced' and they confirmed that students using devices other than their own require time not only to familiarise themselves with the device, but more importantly to 'play around' with the technology".* Thus, in future work, learners should be using such applications on their own device. Furthermore, mobile literacy (familiarity) is considered as an important characteristic for the use of mobile devices in classroom activities [169]. Another important characteristic is that of system usability [170]. Ally [171] pointed out that device usability such as functionalities can affect users' satisfaction. Thus, the use of mobile devices with learning can, to a degree, affect students' experience. Thus, a final application would need to have enhanced usability in order to increase students' acceptance.

6.4 Discussion on Findings on Focus Group

This section reports in-depth the qualitative findings generated from the focus group discussions based on direct comments and feedback from students who participated in the experiments. The results cover the learners' perspectives on the mobile micro note taking application and the evaluation of the micro note taking application for note taking

activity in lectures in relation to **RQ3**. It further covers the extracted themes that were derived from the analyses of data; each theme addresses an issue related to the use of the developed mobile micro note taking application in a class, and reflects the experience of learners regarding their use of the M2NT application for note taking.

6.4.1. Perceptions of Positive Features of the Mobile Micro Note Taking Application

At the beginning, participants were asked about the positive features they found using the mobile micro note taking application for note taking, as described in Chapter 4. The results were consistent with those in the current state of the art, as in Gikas and Grant [31], where students reported the following positive features; the ease of use and that it is a handy tool. For example, participant 1 described the proposed micro note taking application by saying that “it’s simple, no previous experience required, affordable, easily accessible, all have mobile in class”. Participant 4 agreed, stating that: “there is no previous experience required”. Participant 7 mentioned that “it’s an easy tool for note taking”. In this research, another positive point that emerged from the analysis is that the proposed tool is useful and handy. Participant 3 confirmed this point, stating: “you don’t need a paper and pen also there is no need to carry the heavy laptop start typing, really handy”. Participant 13 affirmed what his colleagues said: “it’s simple to your eye. Anyone can use it, even people who don’t have experience”.

Another positive feature is the applicability of using the micro note taking application for quick revision. This capability has been explicitly expressed, as Participant 10 stated: “self-revision, jotting important notes and bring them before the examination, quick review, revision of any last minute study or some test”. Participant 2 affirmed what his colleagues said: “I think it’s good for revision for a quick review of any last minute study or some test, something like that is good”.

Most people use a mobile device such as a smart phone to support their personal and professional functions [166]. Technology is becoming a ubiquitous part of the academic

environment generally and the process of note taking particularly [3]. Mobile devices can be valuable in academic areas for higher education [166]. According to Ward et al. [111] students reported that taking notes using this type of system over traditional pen-paper is feasible. Another study by Motiwalla [172] highlighted the fact that students liked the ease-of-use and convenience of using a mobile application in learning. Consistently, in this study, participants also revealed that one of the main positive features of the micro note taking application is that the proposed application is affordable, convenient and accessible for note taking activity. Participant 9 said that "it's very affordable and is easily accessible because we all have mobiles, but nowadays mobiles are present everywhere. So like it's affordable; it's the best thing that I've had". Participant 3 confirmed this point by saying: "mobile micro note is affordable". As for accessibility, Participant 12 stated: "….read the thing and you can do it anywhere, even on bus or when travelling". Participant 6 also concurred with what her colleague said: "Because it's mobile, it can be easy to carry wherever you go". Participant 14 confirmed this point view by stating: "Because it's mobile, it can be easy to carry wherever you go. So I think it's appealing to the younger generation because they only use or bring their mobiles everywhere". These positive features of the micro note taking application were also explicitly expressed, as Participant 1 stated: "I think people feel comfortable using phones to take notes these days and they are easy to carry around rather than the laptops or pen and paper and it's faster to take notes on. So it's easier to capture what you exactly want. I think it could be useful to have something like this. Definitely".

6.4.2. Perceptions about Negative Features of the Mobile Micro Note Taking Application

When the participants were asked about what the limitations of the micro note taking application were, as described in Chapter 4, they reported that although the application includes many positive features, it does have a number of limitations. These limitations include: the actual smart phones do not offer good size interface or a keyboard, some

students' difficulties such as slow typing that can be connected to usability issues although they had stated earlier that it is easy to use. Moreover, they suggested that this tool may lead to students being distracted during a lecture and that there is a lack of experience due to usability issues. For example, as Participant 7 stated: "on the device itself, the keyboard is quite small to type actually". Participant 11 also gave his opinion "I think because we're not used to typing quickly, I'm speaking for myself, but otherwise it's okay especially I think with the new generation, they are quicker in typing". Similarly, Participant 8 said that: "because when I concentrate listening and I just continue typing, I did not realize that actually the limit is already 140. So, when I look back, actually there's some missing words or sentence already". Participant 6 found that it might be a source of distraction during lectures, and expressed these reservations by stating: "make sure that they take it seriously and they are just not playing with it around". Participant 13 concurred with this by saying: "I found I was constantly having to look at what I'm doing so I lost a bit of concentration. That's because it was more distracting". Only one student, Participant 8, mentioned that the lack of experience in how to use a micro note taking application could lead to limited use of such an application. She mentioned that: "I think the difficulties I faced were just because it's the first time to use it. So, I face a lot of problems and most of my notes wouldn't save because I've just done a mistake, so I didn't save or I just put back and then it's not saved. So I think just because we're not familiar with most of the difficulties". To overcome this limitation, Participant 6 suggested: "I think we need to have some kind of an introduction to the system before getting to take notes". Based on these results, we can conclude that unfamiliarity with using the micro note taking application and usability issues are what led to such negative outcomes.

6.4.3. Perception about Using 140 Characters for Writing Notes

Based on this analysis, two perspectives have emerged when the participants were asked about their preference of using 140 characters for writing their notes. The majority of participants explained that the limited notes of only 140 characters (i.e. similar to Twitter

posts) could improve the ability to take short notes that can be easily managed and recalled later. For example, Participant 1 stated that “using just 140 characters helps us to think of what we want to write”. Participant 14 was also totally in agreement: “I was not distracted as there was no option but to take (down) only important points with limited words”. However, a few participants found that restricted notes of only 140 characters might affect notes in terms of continuity. This concern has been explicitly expressed as Participant 10 stated: “For me it’s the continuity of our notes because it’s only 140 characters so if we write something, you know, the sentence will be hanging”. Therefore, Participant 5 suggested: “…during a lecture I prefer more than 140 characters because during the lecture we just take any notes the lecturer says, so we don’t have time to think about what is important and what is not – just take any notes”.

According to the findings of this study, it can be said that a 140-characters note was a generally accepted format for note taking activity by students, as it could improve the student’s note taking skills, but also there were important reservations.

6.4.4. Suggestions to Improve the Mobile Micro Note Taking Application

The participants were asked to share their experience about the micro note taking application and suggest more features so it could be improved. Based on the analysis, Table 6.7 shows a list of valuable features and functionalities that have been suggested by participants.

Table 6-7: Suggested features and functionalities

Features	Suggested by
Use visual presentation that represents certain words. So each picture has correlated notes.	Participant 5 “Just make it a bit more appealing because it’s very abstract from my point of view and you can use a drag-and-drop thing, like you can give them basically icons that they can do things that have

	pictures and this can open up instead of just making it as simple and abstract as...give them more options, more features and make them an icon thing so they just touch it and a note opens up or, for example, an annotation opens up, or a shape opens up".
Provide a feature to organise a notes (e.g. folders or according to subjects).	Participant 3 "I'm not sure if the pictures are already there or not but may be if it would be helpful if you could organise a note in folders or according to subjects because it seems if you have like different subjects, you could organise all the notes in one folder so it will be easy to access – I think this is one thing".
Annotate the content itself by providing different shapes based on the type of content. For example for student's notes it is a rectangle, for lecture notes it is a circle.	Participant 2 "Basically we're talking about annotating the content itself, because sometimes you need to post somewhere and put a note there. So I think shapes make more sense. Beforehand you can divide the contents into shapes and based on the shapes we can take notes and annotate that directly on the shape or the subject or the idea within the class, just to making random notes and then putting

	them altogether and you might not remember what it was related to. So it is more like correlating what notes have been taken with the actual content. That would help a lot".
Provide options to have short notes and long notes.	Participant 1 *"May be there should be an option to have short notes and long notes".*
Integrate Web 2.0 features (e.g. sharing, Hashtag)	Participant 10 and Participant 12 *"May be for sharing. Let's say we have three of us here … then we can share. So maybe it might be the notes that we take".* *"I think may be also having the feature of hashtag. So having hashtag would help you to organise notes so whenever you use this hashtag to retrieve all the notes which have this hashtag, so that would be may be useful".*

6.5 Conclusion

The evaluation for M2NT produced three different types of results via the main experiment conducted. The first type of result included a quantitative outcome from three questionnaires evaluating the different note taking approaches in addition to a fourth

questionnaire comparing these approaches. The questionnaires answered **RQ2,** which focused on usefulness evaluation measure. The second type of result was obtained from the analysis of students' micro notes and feedback comments. The third type of result was obtained from the post focus groups. The latter two types of results contribute to answering **RQ3** and therefore achieving **OB5**.

Moreover, based on the analysis of the questionnaires, three sources of quantitative findings have contributed to answering **RQ2**: "What is students' perceived experience and usefulness in using a mobile micro note taking application in comparison to traditional pen and paper and electronic word processor?"

The first source of quantitative findings was generated by examining the successful features that are included in the micro note taking applications. Students found that the application helped them in capturing, managing and saving their notes. They also indicated that notes were easy to access, providing safe storage for notes. However, other features were less favoured, such as the ease of remembering in study time and the speed of access to them (section 6.2.2.).

The second source of quantitative findings reflected on whether or not there was a significant difference between the three note taking approaches of pen-paper, electronic word processor and mobile micro note taking application usefulness.

This source of data generated was based on significant statistical tests and significant results (section 6.2.2.) which suggest that perceived usefulness between students does differ depending on the three note taking approaches. This implies that the use of the micro note taking application and other approaches differ in terms of usefulness from learners' experience perspectives. This is achieved because there is a significant difference between students on the three approaches in terms of usefulness. Micro note taking is found to positively affect the students perceived usefulness in terms of capturing notes quickly, managing notes easily, offering safe storage, being easy to read, finding notes relative to a particular question, capturing accurate notes, completing notes,

remembering the lectures and accessing the notes easily. Therefore, the findings above show that the perceived usefulness between learners differs in terms of the three note taking approaches (that are traditional pen-paper, micro note taking and electronic word processor).

Therefore, the second question aims at addressing which perceived usefulness of the mobile micro note taking differs from that of others. The question is answered by the results generated in section 6.2.2 that have produced statistically significant findings. Additionally, within this question which approach exactly differs from each other approach in term of usefulness is identified (Section 6.2.3.). Features related to usefulness such as capturing notes quickly, managing notes easily, offering safe storage for notes, notes being easy to read, finding notes relative to the question, capturing accurate notes, capturing complete notes, remembering the lectures and accessing notes easily shows that that students perceived that the usefulness of mobile micro note taking differs from that of traditional pen-paper. In this sense, the students perceived micro note taking as more useful than they did traditional pen-paper. Moreover, features such as capturing the notes quickly, capturing accurate notes, capturing complete notes, remembering the lectures and accessing the notes easily do differ, indicating that learners perceived usefulness of micro note taking is more positive than that of electronic word processor. However, in features such as managing notes, offering safe storage, reading notes and finding relevant notes, learners did not perceive the usefulness of micro note taking as differing from that of an electronic word processor.

The results generated from the experiment showed a statistically significant difference between micro note taking and traditional pen-paper. Furthermore, there is a statistical significance between micro note taking and electronic word processor in terms of the following features: capturing notes quickly, capturing accurate notes, capturing complete notes, remembering the lectures and accessing the notes easily. However, through the experiment investigation there is no statistical significance to be claimed; thus the results

indicate that there is no significant difference between two approaches of micro note taking and electronic word processor in terms of following features: managing the notes, offering safe storage, reading the notes and finding the relevant notes.

This suggests that students perceived the micro note taking application as more useful than traditional pen-paper with all the features, whereas they perceived micro note taking application as more useful than electronic word processor for most features (Table 6-1 and Table 6-2).

The third source of quantitative findings was compared in terms of whether or not micro note taking application allows the learner to achieve a more useful note taking experience compared with the approaches of pen-paper and electronic word processor (Section 6.2.4).

The comparison results through the experiment had a statistical significance for most features of micro note taking, compared to other ordinary note-taking approaches (namely traditional pen-paper and electronic word processor) in terms of: ease of use, generating better notes, limiting students to writing everything in class, remembering the lecture in exam time, being useful for revision, accessing the notes any time and in any place and reviewing all the notes minutes before the exam. This shows an agreement between users on most of the features except the safe storage feature, as there is no significance which can be claimed in this finding (Table 6-3).

Overall, this shows that using the short content creation feature of microblogging to support students' note taking activity became a successful approach for note taking, compared to the other existing approaches.

On the other hand, the analysis of students' micro notes and the qualitative data (i.e. focus groups and students' feedback comments) have contributed to answering **RQ3**: How does a mobile micro note taking application impact students' perceived experience, and perceived usefulness practice?

The results indicate that limiting the class to just 140 characters for note taking practice (i.e. micro notes) positively affected students' note taking experience. Feedback comments reported at the end of the fourth questionnaire by students resulted in a set of positive and negative features of M2NT. In addition, the comments have also enhanced the understanding of the implications of M2NT on the generated micro notes outcomes.

Moreover, the findings of the focus groups extended our understanding of what students at university level experience while using the M2NT for note taking. In addition, the findings suggested a list of features of what a new note taking system should offer the students and revealed that usability and familiarity issues are the main obstacles to effective use of the application on smartphone for note taking activity. These findings confirmed the importance of usability of the smartphone as a learning tool (section 6.3, section 6.4) [173].

The objectives stated in the introduction in the opening chapter in Section 1.3 have been achieved, and have contributed to answering the research questions.

6.6 Summary

The goal of this chapter was to highlight the results generated from the experiment. The target was to evaluate students' perceived experience and perceived usefulness using the M2NT application. The quantitative outcomes in relation to RQ2 and the qualitative results in relation to RQ3 were also presented.

Chapter 7

7 Conclusion and Future Work

7.1 Introduction

The main aim of this research is to investigate the effect of using the short creation content feature of microblogging (i.e. 140 characters) as a note capturing approach, in a classroom environment at a university-level, in terms of perceived usefulness and the students' experience.

This research aim was crafted on the basis of the recognition that the traditional pen and paper approach for note taking may produce incomplete and inaccurate notes which could not provide the best note taking experience for students. Additionally, with the huge advancement and popularity of mobile technologies nowadays in the field of education technology, it still seems that note taking technology has not developed concurrently.

This chapter aims to draw the final conclusions of this research. In addition, it presents the research contribution, limitations and future work.

7.2 Discussion

This research started with five main objectives to answer the three research questions that are mapped across three phases of research design: an investigation phase to understand the current student note taking activities in the classroom, a development phase to provide a new note taking approach that uses Web 2.0 technology, and an evaluation phase to examine students' experience and perceived usefulness of using the new note taking approach. In order to answer the research questions, a design science research approach was applied in this thesis.

As illustrated in Figure 7-1 the research questions (RQ1, RQ2 and RQ3) have been addressed through the three research design phases (investigation, development and evaluation) as they relate to the research objectives (OB1, OB2, OB3, OB4 and OB5) along with the thesis chapters (CH2, CH3, CH4, CH5 and CH6). In this section, we will discuss how these three research questions have been answered through the research objectives in this extensive research.

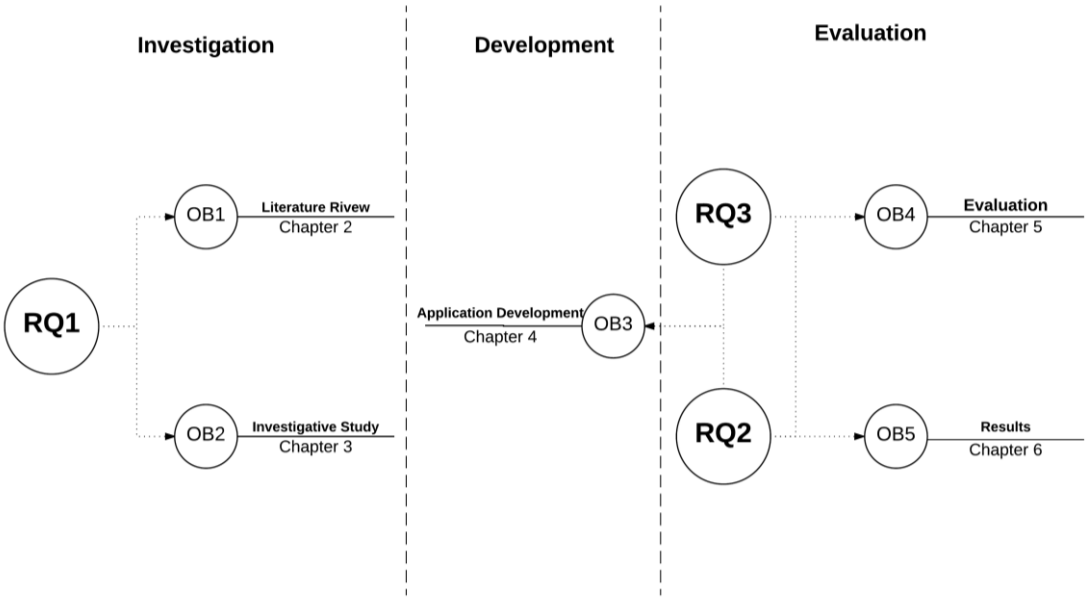


Figure 7-1: Mapping of research questions and research objectives across the research design

The first research question RQ1 investigated the students' perspectives of current note taking activities and mobile note taking applications in the classroom. An exploratory survey was distributed to students at the University of Warwick, targeting first year undergraduate students in both the Computer Science Department and Warwick Business School. The survey, which includes 19 questions, was distributed to 254 students. Moreover, the analysis of the collected data from the investigative study (Chapter 3) showed that the majority of students still use traditional pen and paper for note taking. It was highlighted that students had no motivation to use the state-of-the-art mobile note taking applications that were available before M2NT was proposed (see Figure *3-14*). In

addition, the reported fact via this investigative study is that the produced notes by students are mostly incomplete or inaccurate, which may not result in the best note taking experience.

Moreover, the investigative study highlighted that students would appreciate sharing notes on a new mobile application, although the vast majority do not appreciate taking notes using mobile devices. The study also highlighted the Twitter features such as Web 2.0 features to be adopted in new application. In addition, the study showed the importance of incorporating the short content creation feature of microblogging. The analysis of the investigative study also revealed that lack of motivation hinders students from using the previously available state-of-the-art note taking applications. These insights from the investigative study highlight the importance of developing a new note taking approach that incorporates Web 2.0 and mobile technologies for delivering a better note taking experience in the classroom.

Therefore, answering **RQ1** has resulted in supporting the design and implementation of the proposed micro note taking application. Thus, the generated results from the investigative study helped to determine the requirements for developing the new note taking application.

The second research question RQ2 investigated the students' experience and their perceived usefulness between three distinct note taking approaches which are traditional pen and paper, M2NT application and electronic word processor.

An experiment was conducted with 42 participants. Data was collected through a survey questionnaire that consisted of nine items relating to each approach - traditional pen and paper (questionnaire A), M2NT (questionnaire B) and electronic word processor (questionnaire C). An additional eight questions were used to compare the usefulness between the M2NT application and either traditional pen and paper or electronic word processor. Questionnaires were used to evaluate the three note taking approaches aimed at addressing the perceived usefulness of the M2NT application.

The analysis highlighted that students' perceptions of the usefulness of M2NT in relation to other existing approaches are more positive, specifically in terms of accessing their notes. The M2NT application was found to be mostly successful as a way to access note taking. All other features such as managing notes, safe storage of notes, and accurate collection and completeness of notes were positively affected by the note taking practice using M2NT. Despite the fact that all of the results could be considered positive, other features were not as successful for the M2NT application as those previously mentioned. These features include the quickness of note capturing, the ease of remembering and reading the notes, and finding the relevant notes at revision time.

The data analyses indicated that there is a difference between students' perceived usefulness in regards to the evaluated three note taking approaches. Moreover, evidence of significant differences via ANOVA test was found between the three note taking approaches in terms of students' perceived usefulness. To obtain more accurate results, the Bonferroni method was used. It was clearly found that students reported a greater degree of perceived usefulness in regards to M2NT than they did in regards to either traditional pen and paper or electronic word processor.

In order to examine whether the M2NT application was more useful than the two other approaches, a set of eight questions was utilised to compare M2NT with the approaches involving pen and paper and electronic word processor. It was found that most students felt positive in using M2NT for note taking, compared to the other two note taking approaches. Furthermore, significant evidence was found for students' perceived usefulness of most of the features of M2NT, based on a t-test conducted.

The overall outcomes indicate that students were more positive about using the M2NT application for note taking activity than using traditional pen and paper. In regards to word processors, M2NT showed a positive experience by students in four areas; capturing the

accuracy of the notes including exact points mentioned; capturing the completeness of the notes a student needs; remembering the lecture in study time; and easy accessibility of notes. Moreover, this indicates that the usefulness of the M2NT application supports students' note taking activity to a greater extent than the traditional pen and paper approach or an electronic word processor in the previously mentioned areas. In general, the study suggests that students' perceived usefulness of the M2NT application is an improved approach. Therefore, answering **RQ2** shows that the students' experience was positive, and perceived as having a significantly greater degree of usefulness with regard to using the M2NT application. However, these results are based both on students' actual experience with the application, as well as their projected future work with a similar kind of application, and hence, the interpretation of the results needs to take this into consideration. A longitudinal study would be required in future research, to further prove the validity of the current findings (see Section 7.5).

The third research question RQ3 in this research aimed at investigating the influence of using the short content creation feature of microblogging for note taking activity on students' experience. The target was to understand the implications of micro note taking on the notes produced using the application. Data was collected through post focus groups and students' feedback at the end of the questionnaire in relation to their experience after using M2NT. In addition, two focus groups using a semi-structured method were conducted. The groups consisted of 14 postgraduate students who took part in answering the questionnaires of the main experiment. In addition, in terms of the students' feedback at the end of the questionnaire on using M2NT, 25 out of 42 students left feedback on the last part of the questionnaire on their experience. Moreover, students' feedback was analysed using a content analysis technique. The results of the qualitative approach suggested that students had a positive experience using M2NT application. More specifically, based on the content analysis conducted on students' positive feedback, six main advantages of M2NT application were identified: note taking

empowerment, effective note taking, efficient note taking, the recall of notes and retrieval advantage, mobility advantage, and convenience advantage. The aforementioned positive features of M2NT application were also recognized, based on the content analysis of the data collected from the focus groups.

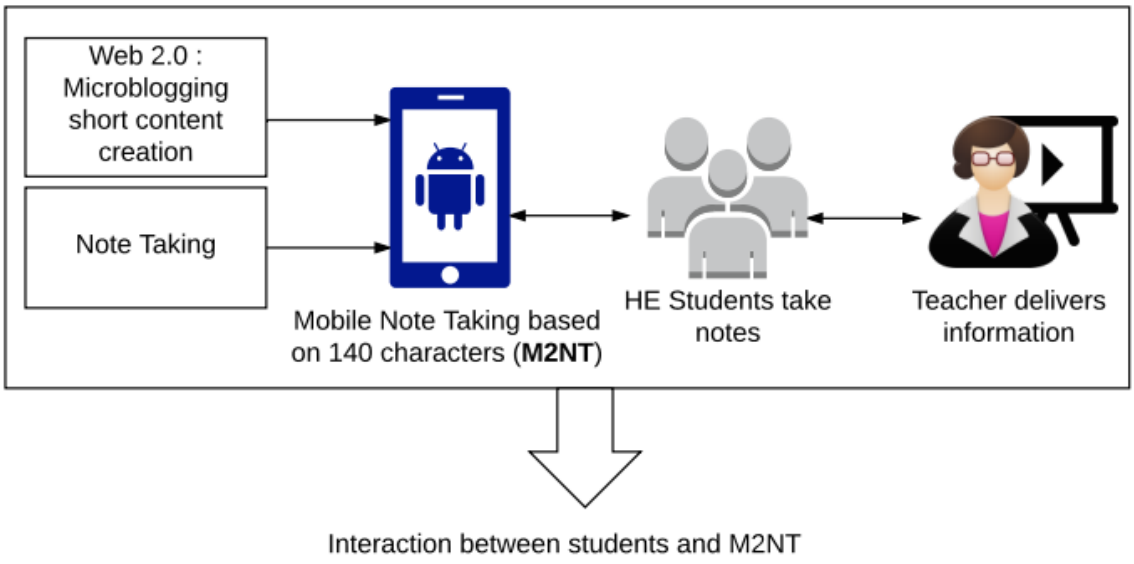
However, based on the content analysis conducted on students' negative feedback, four main disadvantages of M2NT application were identified: mobile device constraints, distraction, unfamiliarity, and note size limitation. The aforementioned disadvantages of M2NT application were also acknowledged, based on the content analysis of the data collected from the focus groups.

Based on the above discussions, the features mentioned by the students related to the educational benefits of M2NT can be summarised as follows: easy to use, not to write everything in the lectures, remember the lectures, useful for exam revision, easy to access, fast and short, time saving, last minute study approach, mobility advantages.

The work in this final chapter pulls together the key findings of M2NT as shown below in Figure 7-2. This figure presents the micro mobile note taking model which bridges the theoretical and practical research in this thesis (Chapter 2, Chapter 3). In this study, the students' experience was evaluated when using M2NT (Chapter 4). Moreover, different research approaches were applied, for example: quantitative and qualitative, to evaluate the experience of the students using M2NT (Chapter 5). The key findings can be presented as follows: **positive results:** easy to use, easy to access, fast and short, time saving, mobility advantages, help to remember the lecture, useful for review later for exam, mobility advantages, **negative results:** unfamiliarity and mobile device constraints.

As a final conclusion and based on the discussion above, this research highlights that using Web 2.0 technology in mobile devices for note taking activities is generally perceived as useful by students, and is able to provide them with a positive experience. According to Teo et al [181] usefulness is a form of extrinsic motivation. Therefore, it can be concluded that perceiving the usefulness of Web 2.0 technology (i.e. short content

creation feature) in mobile note can motivate students to use mobile note taking applications.



Positive Features (M2NT)	
Easy to use	Easy to access
Time saving	Remember the lectures
Fast and short	Mobility advantages
Useful for exam revision	Last minute study approach
Negative Features (M2NT)	
Mobile device constraints	Unfamiliarity

Figure 7-2: M2NT Model

7.3 Research Contribution

The contribution of this research is multifold. This research provides four main contributions to the existing body of knowledge in the field of educational technology. First, this research contributes by critically reviewing the literature related to the use of advanced technologies for note taking activities in a classroom environment. As shown in

Section 2.7, the research also identifies gaps in the literature in this domain of mobile note taking. Therefore, the literature explored the state-of-the-art in the field of mobile technology, Web 2.0, microblogging technology and note taking. Furthermore, it builds the foundation for understanding that supports the design and development of a mobile note taking application using microblogging technology.

The second contribution of this research revolves around exploring students' perspectives towards mobile note taking applications in the classroom via an investigative study. This is deemed to be significant, given that previous studies highlighted the importance of using technologies to achieve an enhanced note taking experience in the classroom environment. However, there has been no investigation to identify appropriate features from advanced technologies (i.e. Web 2.0) to be used for note taking. Moreover, most of the studies used Web 2.0 platforms that are not designed for educational purposes. Therefore, this investigative study has found that the feature of short content creation in microblogging might achieve a better note taking experience. Understanding the need for such a feature through the investigative study supported the design and developing of the new mobile note taking application M2NT.

The third contribution of this research is about scientifically demonstrating the advantage of M2NT over the traditional pen and paper, and also over word processors in regards to note taking activity. Following a methodological approach that was used in the main experimental study, this research revealed that M2NT is perceived to be more useful than traditional pen and paper from a student's perspective. Further, this research revealed that M2NT is perceived as more useful from a student's perspective than the word processor in regards to the following features: capturing accuracy of the notes, capturing the completeness of the notes, remembering the lecture in study time, and easy accessibility of notes. M2NT was not found to be significantly more useful than the word processor in these features: managing of notes, offering safe storage, reading the notes as well as finding the relevant notes at revision time. Therefore, it is recommended that

future research tackles the aforementioned features for further investigation and understanding.

The fourth contribution is focused on the implications of the M2NT application on perceived usefulness and students' experience. As mentioned earlier in Section 6.3, a set of positive and negative features of the M2NT application were identified. In fact, it was found that students perceive that convenience, recall and retrieval for later use, as well as efficient note taking to be the most beneficial features offered by the M2NT approach. However, it was also found that students perceive mobile device constraints and the lack of familiarity as the main disadvantages of the current M2NT application.

7.4 Research Limitations

As with any other study, this research is not free from limitations. These limitations can be summarised as follows.

- The number of participants was 42. This sample thus has limited generalizability, due to its small size.
- The study was conducted in one university with a small group of students in the UK, which also limits generalisation.
- The researcher was not provided with access to different levels of students at the university to deliver more comprehensive results.
- The smartphone devices used were prepared for the experiment purpose, introducing the limitation of experiment. The mobile phones were not the students' own phones. They were prepared for evaluation purposes to use in the experiment to minimise effort in the experiment time, and most importantly, they were used due to limitations in terms of time available for the researcher.
- No training for using the prepared smartphones was given to the students before conducting the experiment, due to time limitations, which led to usability and familiarity issues.

- The experiment in this study was not conducted in a real live lecture, due to the difficulties in organising this.
- No use for notes has been taken into consideration after the experiment, although the students evaluated the notes through micro note taking as useful for later review.

Despite the challenges and limitations which have arisen above, this research provides initial and insights into the study of short content creation feature of microblogging as a capturing approach at class level to support note taking activity in relation to its perceived usefulness and students' experience.

7.5 Future Work and Recommendations

Finally, it needs mentioned that whilst the focus in this research was on note taking and on the students' experience, the overall research is placed in the larger area of computer-supported higher education. Thus, future work should further look at the educational implications and benefits that this approach can bring. In this respect, this research points towards educational benefits such as useful for later review, capture the notes easily and manage the notes.

Moreover, as this study is one possible study of the research chain, numerous related areas need to be further investigated. It has also been discussed throughout this thesis that the developed M2NT is at an early stage, but that it suggests an innovative way for note taking activity. Thus, other potential directions for further research can be summarised as follows.

- Conducting the study with a large number of students at different university levels. This would help to generalise the findings and gain more comprehensive results as regards the evaluation of M2NT.
- As this study explores a new stream of research, at an early stage it is worth studying the adoption of this new innovation for note taking approach.

- Conducting this study in a real lecture to gain more reliable and comprehensive results. This would help to reach a high level of data collection.
- The application should be available for more than one mobile platform, which has been considered in this research. It was due to time limitations and lack of resources that the application was developed solely for an Android platform. Developing the application on a different platform would be useful to enable evaluation to be extended to the participants, no matter what kind of device they use. Therefore, usability and familiarity problems would be reduced, as they will be using their own devices on different platforms.
- Special training for using the devices should be considered to familiarise students with mobile devices that are not their own.
- Long-term use for the application should be considered to test the impact of using the notes produced through M2NT on students' performance.
- Collaborative note taking with fully microblogging features in a mobile application in a classroom environment can also be explored.
- In the future, some educational benefits of M2NT require further examination, such as remembering the lectures and exam revision.
- Future work could look at the challenges of mobile note taking based on 140 characters to support, for example, meetings.
- Further studies should move beyond the classroom and examine the experience of people use mobile micro note taking in diversity setting: boardroom, hospital room and courtroom [183].
- Another area of further research could be focusing on measuring the effect of using M2NT on the summary that students can produce based on their captured notes from the presented information, in order to investigate measurable impacts of mobile note taking based on 140 characters on the ability of the students to learn in the class.
- It is especially recommended that the current work be applied to a large sample of participants from different levels at the university, which can validate the current findings, by using different research approaches, to measure the students' performance using M2NT in the class.

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Annex I: Approvals Letters and Consent Form

27th March 2013

Warwick Medical School

PRIVATE
Maram Al-Zaidi
Staff Flat 12
Lakeside Apartments
Gibbet Hill Road
Coventry
CV4 7AL

Dear Maram,

Study Title and BSREC Reference: *Micro Mobile Note-Taking Platform – REGO-2013-034*

Thank you for submitting your revisions to the above-named project to the University of Warwick Biomedical and Scientific Research Ethics Sub-Committee for Chair's Approval.

I am pleased to confirm that I am satisfied that you have met all of the conditions and your application meets the required standard, which means that full approval is granted and your study may commence.

I take this opportunity to wish you success with the study and to remind you any substantial amendments require approval from the committee before they can be made. Please keep a copy of the signed version of this letter with your study documentation.

Yours sincerely,

David Davies
Chair
Biomedical and Scientific
Research Ethics Sub-Committee

Biomedical and Scientific Research Ethics Subcommittee
Enquiries: Amy Ismay
A010 Medical School Building
Warwick Medical School,
Coventry, CV4 7AL.
Tel: 02476-151875
Email: A.C.Ismay@warwick.ac.uk

THE UNIVERSITY OF WARWICK

19th January 2015

Warwick
Medical School

PRIVATE
Maram Al Zaidi
PhD Student
Computer Science
University of Warwick
Coventry
CV4 7AL

Dear Maram,

Study Title and BSREC Reference: *Comparison of Three Note- Taking approaches*, REGO-2014-1302

Thank you for submitting your revisions to the above-named project to the University of Warwick's Biomedical and Scientific Research Ethics Sub-Committee for approval.

I am pleased to confirm that approval is granted and your study may commence.

Please keep a copy of the signed version of this letter with your study documentation.

Yours sincerely

P.P. Graham Howarth

David Davies
Chair
Biomedical and Scientific
Research Ethics Sub-Committee

Biomedical and Scientific
Research Ethics Sub-Committee
A010 Medical School Building
Warwick Medical School,
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THE UNIVERSITY OF
WARWICK

THE UNIVERSITY OF WARWICK

BIOMEDICAL AND SCIENTIFIC RESEARCH ETHICS COMMITTEE TEMPLATE CONSENT FORM

Study Number: Title of Project: Comparison of Three Note-taking Approaches for Education

Name of Researcher(s): Maram ALZaidi PhD Student @ University of Warwick computer science and Academics Supervisors Dr. Mike Joy and Dr. Jane Sinclair]

Please tick all boxes

1. I confirm that I have read and understand the information sheet dated **[7.1.2015]** for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. ☐

2. I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason, without my rights being affected. ☐

3. I understand that the study is a survey to evaluate a proposed micro note-taking approach compared to a traditional approach and an electronic approach. ☐

4. I can request a copy of the research findings at any time from the author. ☐

5. I give permission for the researcher to record the focus group/data gathering process. ☐

6. As a way of protecting your anonymity I will not use your real name in any reported research outputs (e.g. thesis conference, presentations, papers and articles). ☐

7. The findings of this research may be used as a contribution to a peer-review journal paper. ☐

8. I give permission for the researcher to collect and analyze the notes that I have made during lectures. ☐

9. I agree to take part in the above study. ☐

Name of Participant Date Signature

……
……..

Name of Person Date Signature taking consent

……..
…….

Annex II: Exploratory Survey

Questionnaire for Investigative Study

Note taking issues and Micro Note taking Platform Survey

Introduction

Thank you for agreeing to take part in this survey. We are conducting research to evaluate the importance of note taking during lectures. We would like to hear about your current note-taking practices and your view on how they could be better supported. Please be assured that your responses are strictly confidential and will only be used for research purposes as the survey is anonymous. Individual participation will not be identified in the analysis as only aggregated results will be analyzed and presented.

The survey will take about 10 minutes to complete. For the majority of questions please simply tick one or more options as appropriate in the squares (□) and optionally write in the dotted space (……..)

Section 1: Demographic data

1. Gender □ Male □ Female
2. Age □ 18-21 □ 22-25 □ Above 25

Section 2: Current note-taking strategies during lectures

3. How important is note-taking during lectures? (Tick only one).

- □ (1) Extremely important
- □ (2) Important
- □ (3) Neutral
- □ (4) Not very important
- □ (5) Not important at all

4. How often do you usually take notes during lectures? (Tick only one).

□ (1) Frequently
□ (2) Occasionally
□ (3) Never

If you have answered **Never** in the previous question, then please write down why you did

NOT take notes during lectures, and then skip to Question 13:

……

……

……

5. Have you ever asked your friends for their lecture notes?

- □ (1) Yes
- □ (2) No

6. If yes, why do you ask your friends for their lecture notes? (Tick all that apply)

- □ (1) My notes are not always complete
- □ (2) To check the accuracy of my notes
- □ (3) I usually do not take notes by myself during lectures
- □ (4) Other, (please specify): ……...

7. Why do you take notes during lectures? (Tick all that apply).

- □ (1) Capturing the important points during lecture
- □ (2) Helping to focus attention on the lecture
- □ (3) Organizing your ideas about the lecture
- □ (4) Helping you remember the lecture
- □ (5) Aiming to increase your understanding of the lecture
- □ (6) Reviewing at the exam time
- □ (7) Other (please specify): ……. ……...…….

8.Which of the following are likely to motivate you to take notes at a particular point in a lecture? (Tick all that apply).

- □ (1) A difficult content is introduced
- □ (2) Lecturer repeats a point or stresses its important
- □ (3) Lecturer encourages you to take notes
- □ (4) New material is introduced
- □ (5) Material is written on the board
- □ (6) Other, (please specify): …… ……..……..

9. Which of the following note-taking strategies have you used during lectures? (Tick all that apply).

- □ (1) Pen and paper
- □ (2) Audio recording
- □ (3) Word processor (e.g. Notepad, Microsoft Word, etc.)
- □ (4) Note-taking applications (e.g. Evernote, Microsoft OneNote, etc.)
- □ (5) Other, (please specify): ..……..

……

10. Have you shared your lecture notes with your friends?

- □ (1) Yes
- □ (2) No

11. If you shared your lecture notes with friends, how did you make them available? (Tick all that apply)

- □ (1) Lent the original notes
- □ (2) Photocopied the notes
- □ (3) Via email
- □ (4) Via mobile phone camera
- □ (5) Via Web 2.0 applications (e.g. Facebook, Twitter, etc.)
- □ (6) Other, (please specify): ……

11a. If you have used Web 2.0 to share the notes, how did you share them? (Tick all the apply)

- □ (1) Posted them on the wall
- □ (2) Sent them as a direct message

12. Have you ever used any mobile note-taking application (e.g. Evernote, OneNote, etc.) during lectures?

- □ (1) Yes
- □ (2) No

If yes, then please specify which ones: ……

13. What do you think the factors that affect you **NOT** to use a mobile note-taking application (e.g. Evernote, OneNote, etc.)? (Tick all that apply)

- □ (1) Do not know about them
- □ (2) Difficult to use
- □ (3) Cannot interact with my friends using them
- □ (4) Do not provide the functionalities are required
- □ (5) No motivation to use them
- □ (6) Not a convenient way to reach my notes
- □ (7) Other, (please specify)……..

14. Which of the following mobile devices do you carry during lectures? (Tick all that apply)

- □ (1) Laptop
- □ (2) Tablet
- □ (3) Smartphone
- □ (4) Other, (please specify): ……

Section 3: Web 2.0 uses

15. Which of the following Web 2.0 applications do you use? (Tick all that apply)

- □ (1) I do not use any social network
- □ (2) Facebook
- □ (3) Twitter
- □ (4) LinkedIn
- □ (5) Google+
- □ (6) YouTube
- □ (7) Other, (please specify): ……

16. Have you accessed your Web 2.0 application during lectures?

- □ (1) Yes
- □ (2) No

16a. If you have accessed your Web 2.0 application during lectures, why did you choose to do so? (Tick all that apply)

- □ (1) Check the latest posts or news
- □ (2) Post news, videos or photos
- □ (3) Play games
- □ (4) Chat with friends
- □ (5) Educational purposes (e.g. group discussion, asking questions, etc.)
- □ (6) Other, (please specify): ……..

16b. If NO, what do you think are the factors that affect you NOT to access your Web 2.0 applications (e.g. Facebook, Twitter, etc.)? (Tick all that apply)

- □ (1) Distracting your attention during lecture
- □ (2) Time consuming
- □ (3) No educational value related to lecture
- □ (4) Other, please specify: ……

Section 4: Future expectations from current note-taking practices

17. Would you appreciate an application that would offer you the chance to share your classmates' notes?

- □ (1) Yes
- □ (2) No

18. Would you appreciate using a new application for note-taking on your mobile device rather than using the traditional hand written notes methods?

- □ (1) Yes
- □ (2) No

18a. If yes, then please give your scale for the following functionalities from very important to not very important.

	Very important	**Important**	**Neutral**	**Not important**	**Not very important**
a) **Short notes**	□	□	□	□	□
b) **Sharing notes**	□	□	□	□	□
c) **Post videos, audio and photos**	□	□	□	□	□
d) **Social interaction (e.g. comments, like/dislike, etc.)**	□	□	□	□	□

18b.If No, then can you tell us why?

……

19. Which one of the following Web 2.0 platforms would you prefer to be adopted in a new application for note-taking?

- □ Facebook
- □ Twitter
- □ Google+
- □ LinkedIn
- □ YouTube
- □ other

Thank you very much for your valuable participation

Annex III: Figures and App Guidance Sheet

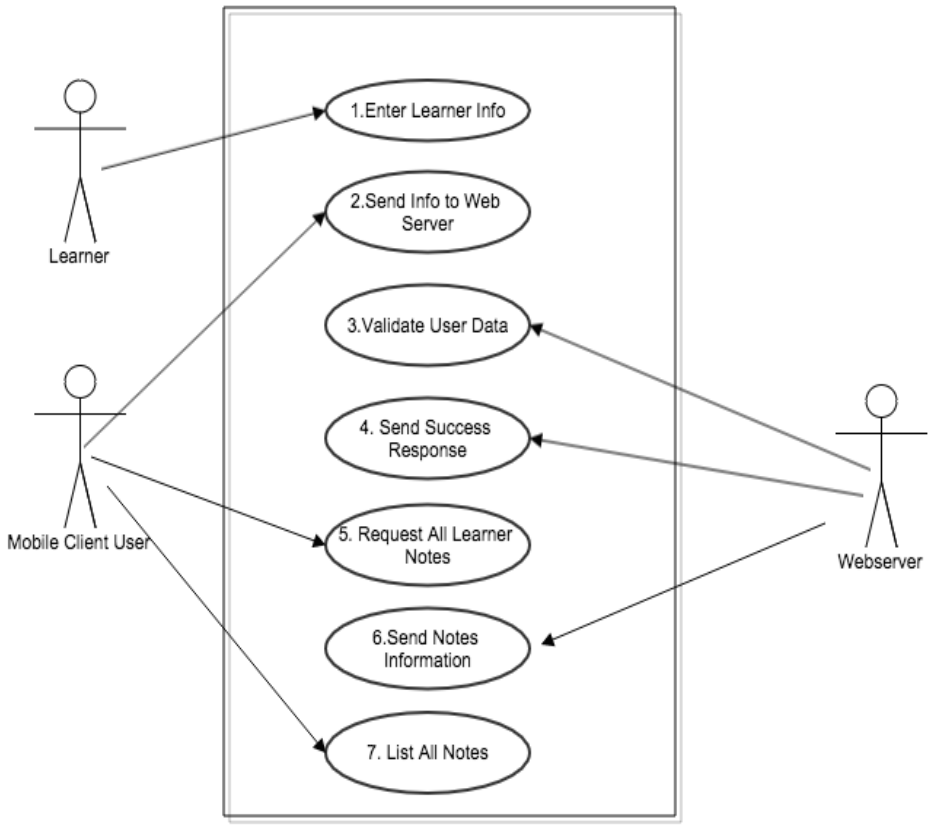


Figure 1. List all the notes

Figure 1 shows the list of all notes use case diagram. The student enters their information on the application. The mobile client user sends this information to the web server. The web server then validates the data sent by the web server and sends success response. The mobile client use requests the students' notes from the web server. The web server sends the students' notes based on the student request. and the mobile client server at the end lists all the requested notes.

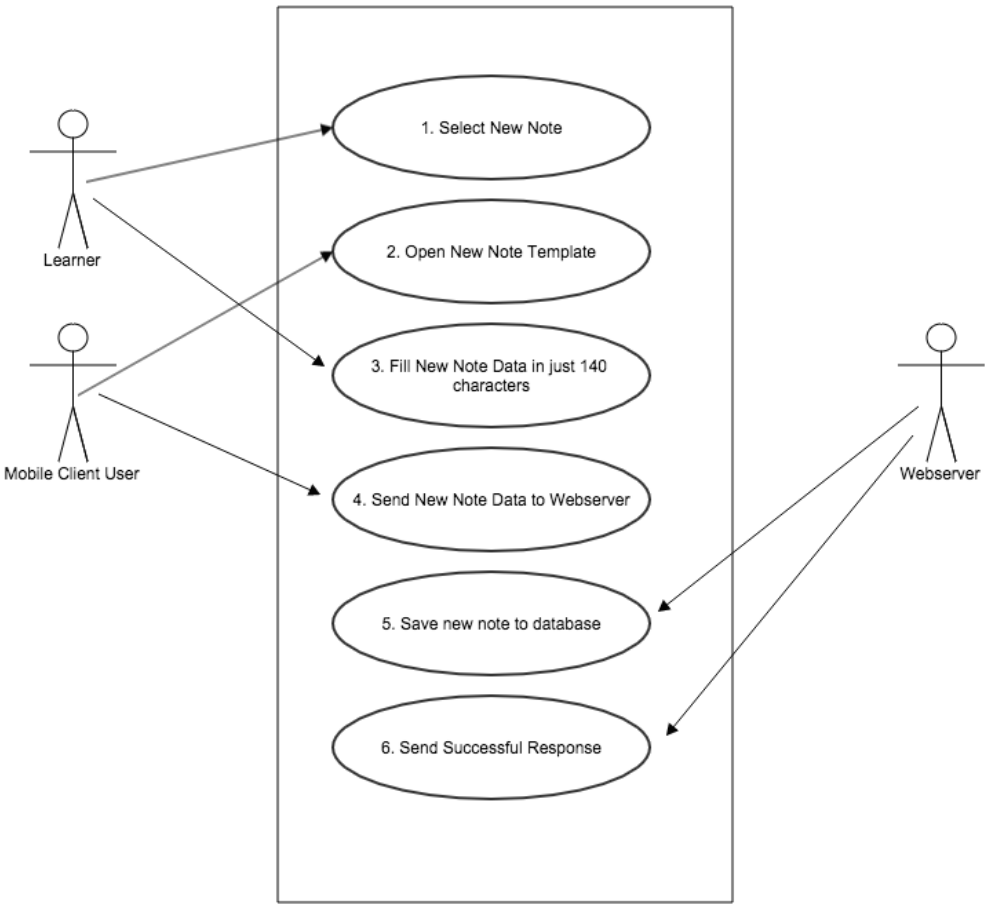


Figure 2. New Note

The use case in Figure 2 presents writing a new note diagram. The student selects the new note. Then the mobile client user opens a new note template so that the student can fill the new note. After that the web server sends the new data to the web server. The web server carries out two tasks: first sending the new note to the database and the second task is to send a successful response to the s.

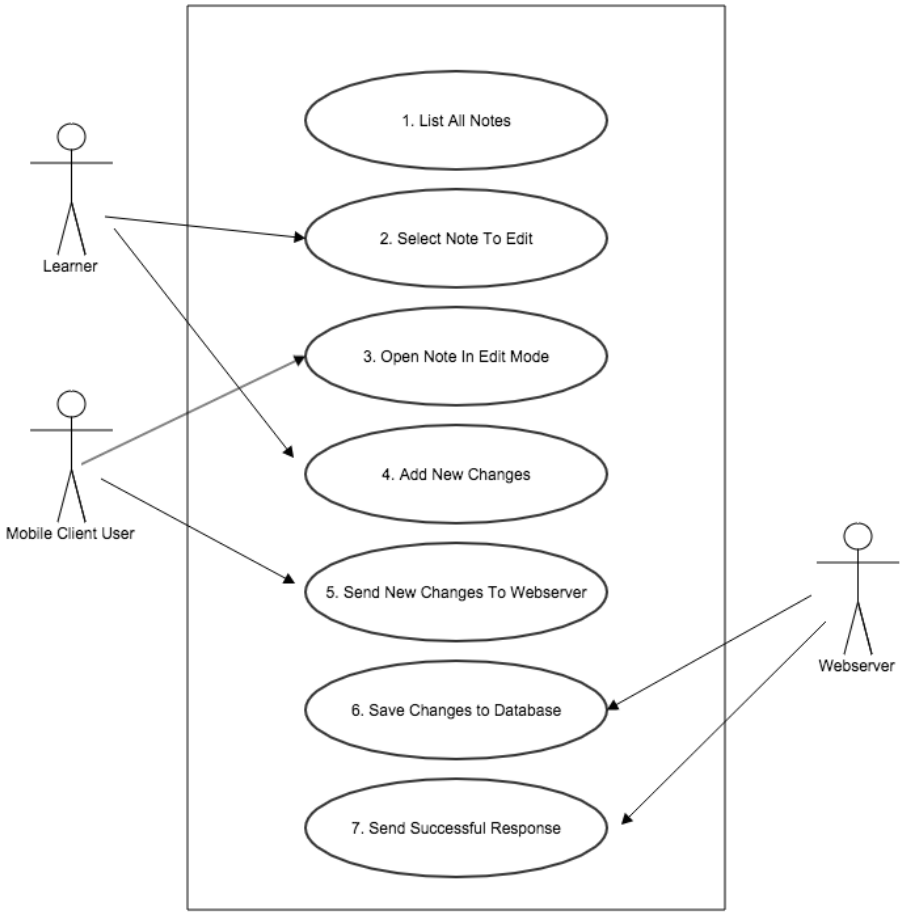


Figure 3. Edit Note

Figure 3 displays editing the note use case diagram. Notes were listed as described in Figure 1. The student selects the note in edit mode. The client mobile user opens the selection noted by a learner in edit mode so that student can add to the edit or add the new changes then the mobile client user sends the changes to the web server. The web server carries out two tasks: sending the changes to the database and also sending the successful response to the student.

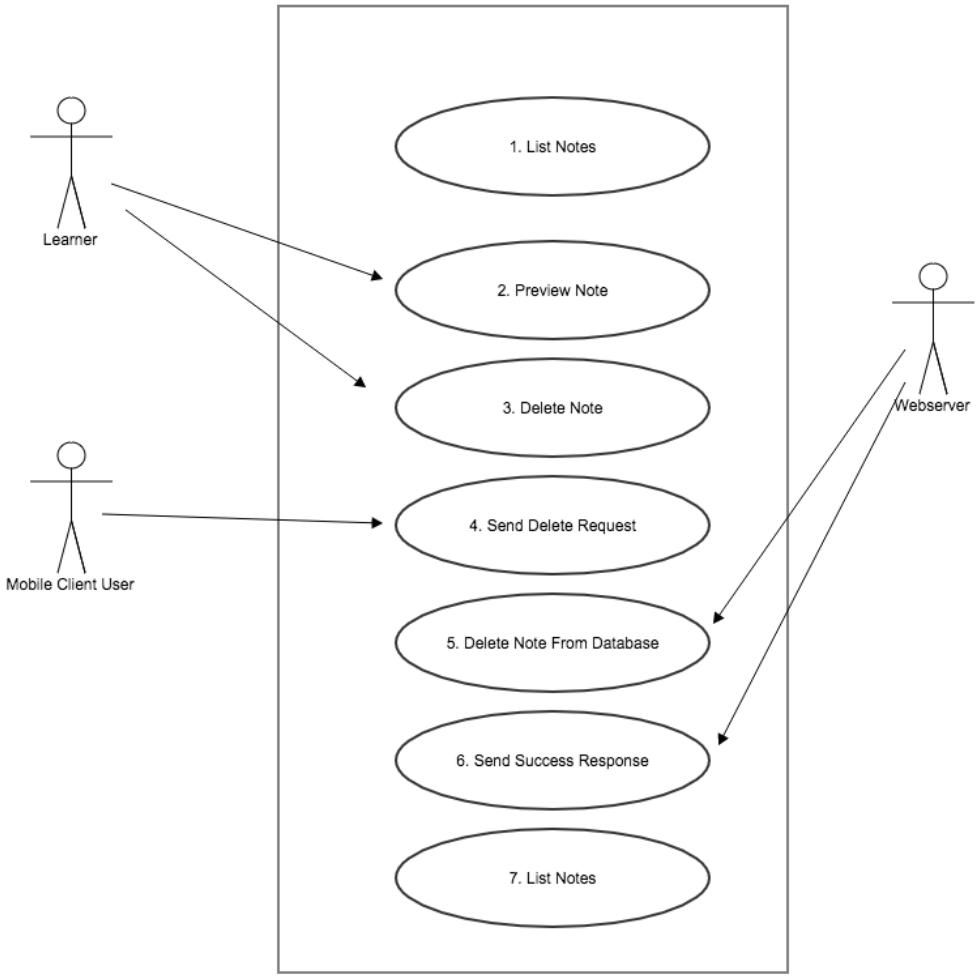


Figure 4. Delete Note

The diagram Figure 4 displays deleting the note use case. Notes were listed as shown in Figure 1. The leaner previews the notes and deletes the note. Then the mobile client user sends a delete request. The web server deletes the note from the database and sends the successful response to the student. Notes were then presented without the note that the student requested be deleted.

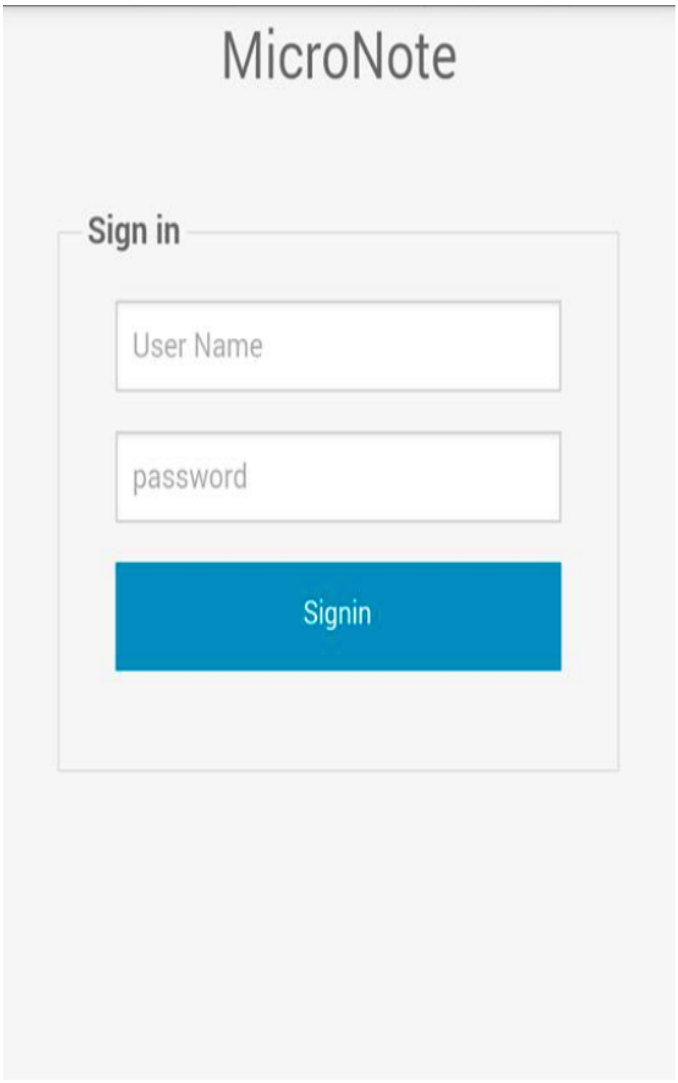


Figure 5. Sign in page

Figure 5 is a sign page to the application. The researcher provided the students a random username and password to be use in the experiment. Hence the students will be able to use the application in the determined experiment time.

For example:

Username A10A10

Password A10A10

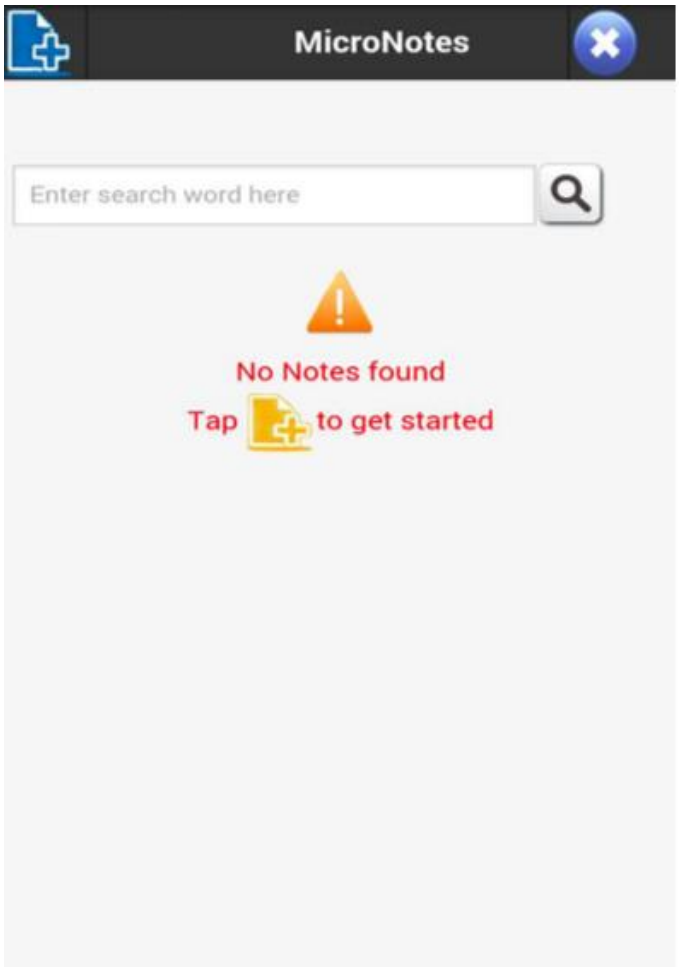


Figure 6. Home Page

Figure 6 shows the application home page where all the notes appeared. To start typing the note the students should press on the add button on the left screen side. Once the students requested adding the new note next Figure below 7 is shown.

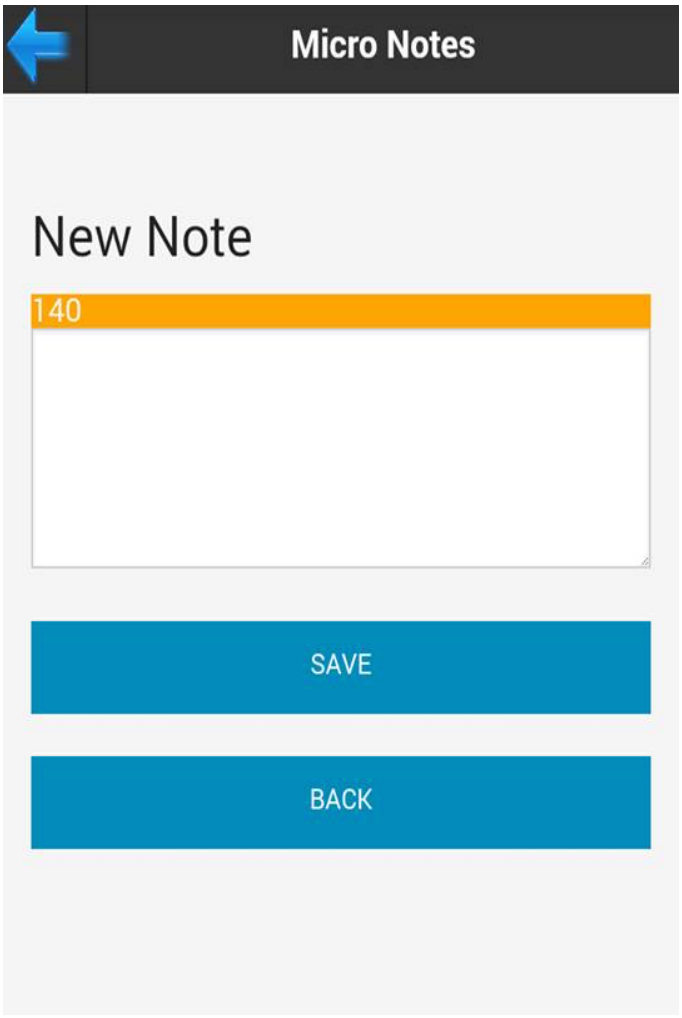


Figure 7. New Note

Figure 7 is a new note page showed the space that students can use for typing the note. The top of this space label worked as a counter for a number of the word as the students are limited to 140 characters for each note. In other word this counter is decreased with the each letter typed for the note.

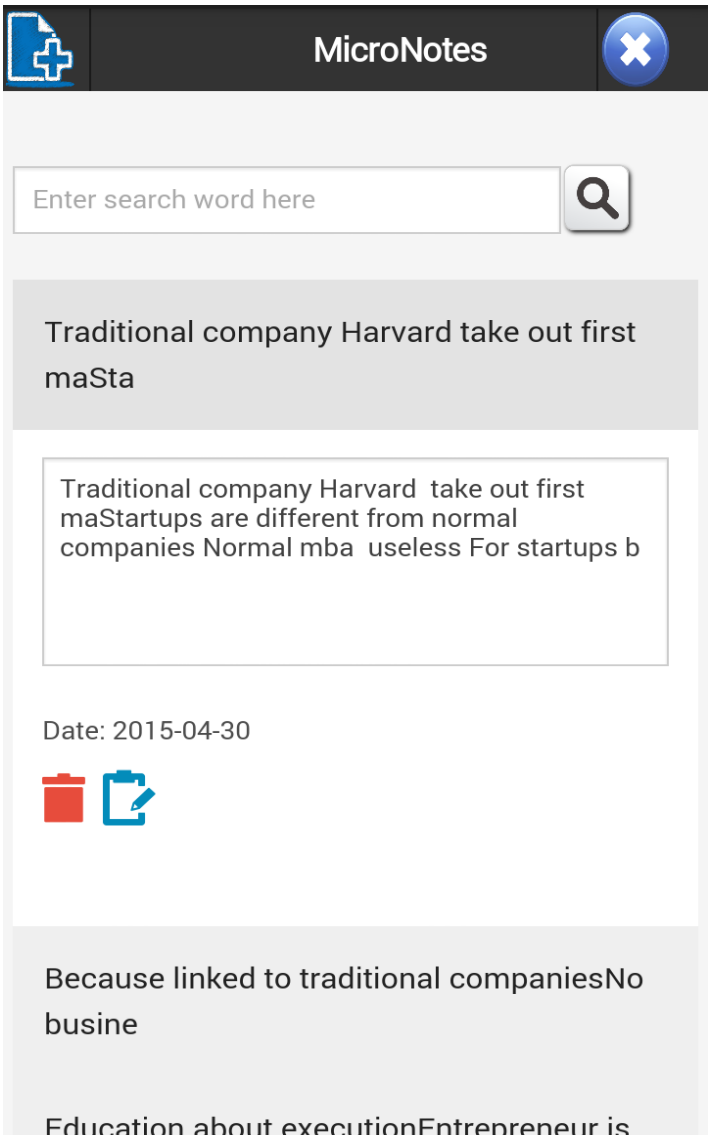
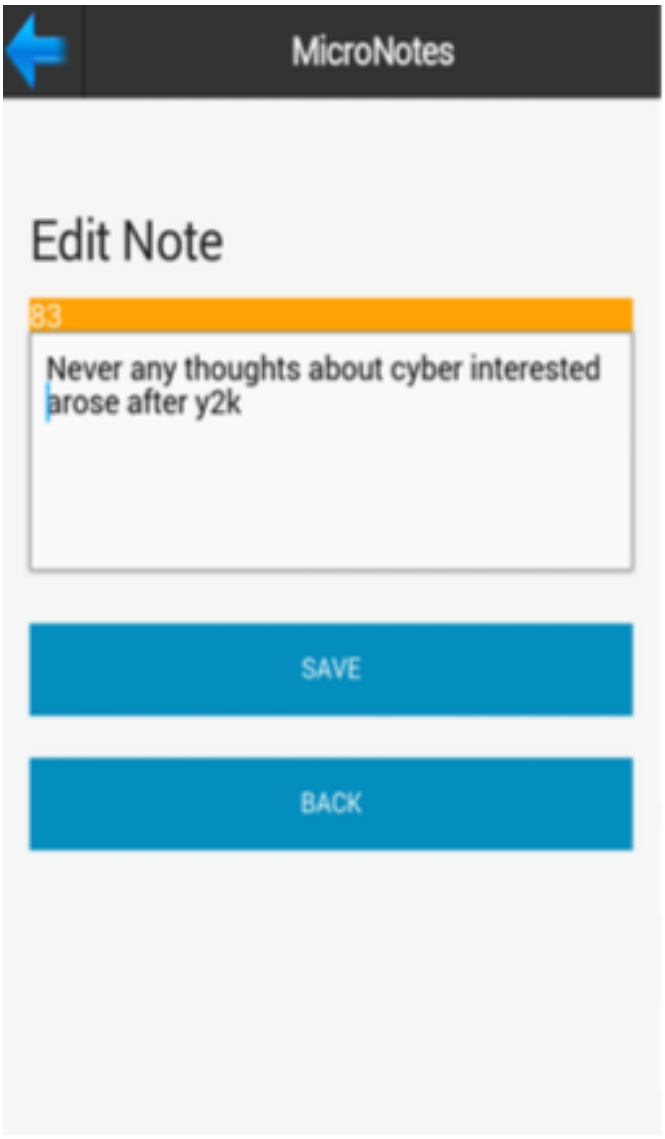
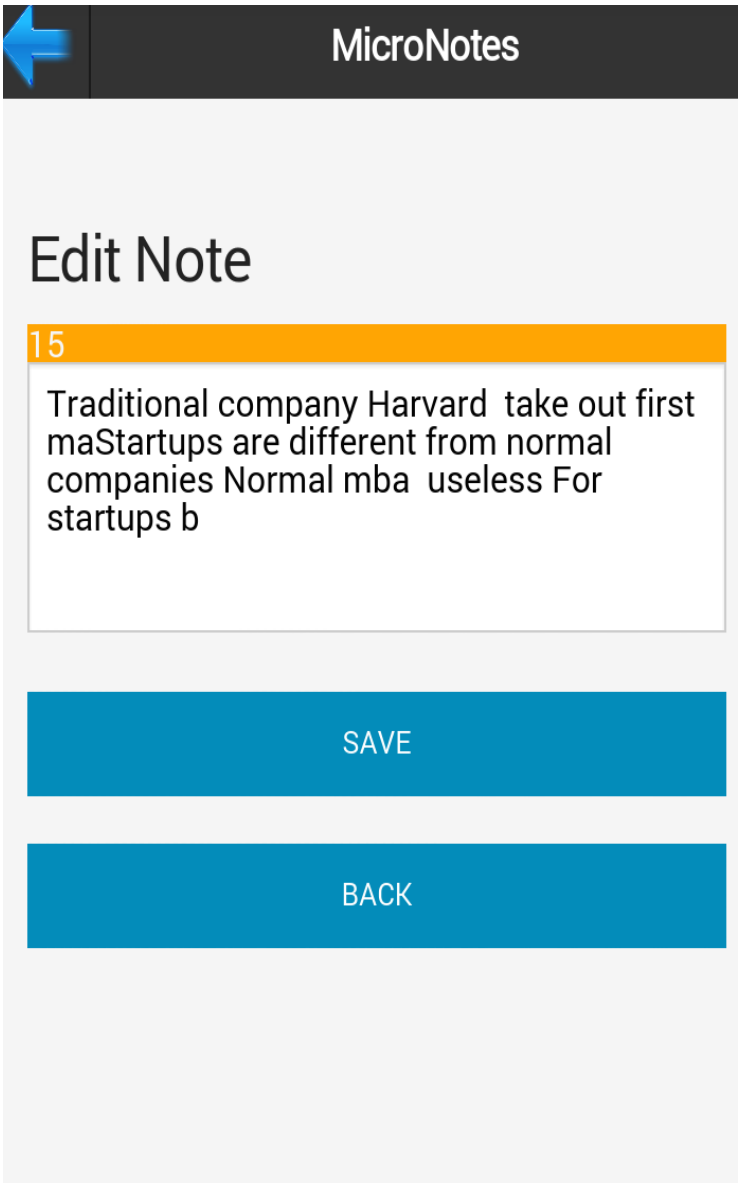


Figure 8. Edit Note

This is to show how students edit or delete the note. To choose the service, the student clicked on the note itself and then pressed on either the edit icon or delete icon. Once the student chooses the service: edit or delete, the student is allowed to make any changes in the note or deleted from the note page.


MicroNotes
Edit Note
83
Never any thoughts about cyber interested arose after y2k
SAVE
BACK



The above Figures are shown the edit note page. It concerns editing the note after typing where the student can easily edit and change the note. There are two options in the page: save and back. Save when students finished with editing the notes and need to save the changes whereas back option where learner can back to the home note page with no changes made to the note.

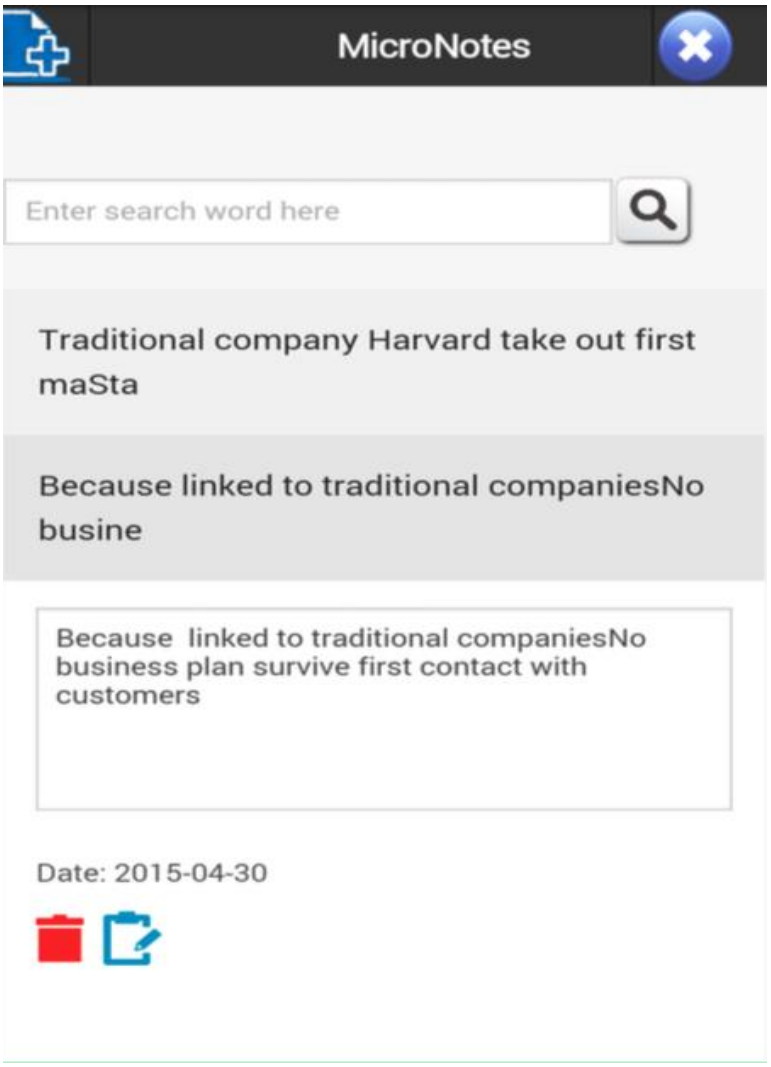
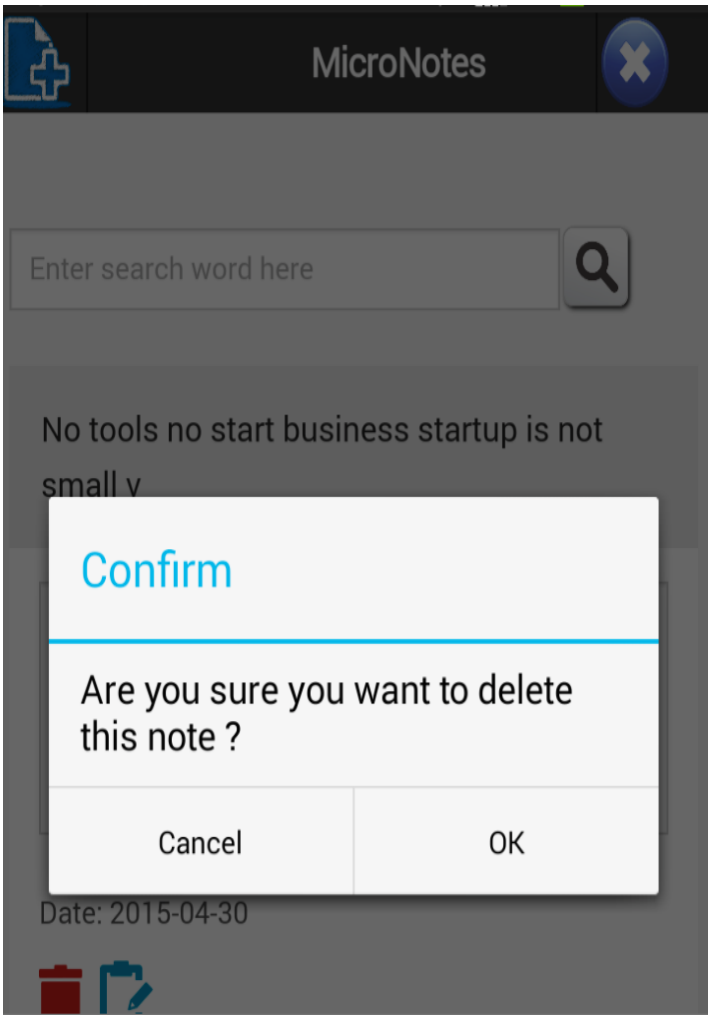


Figure 9. Delete Note



The above two Figures are delete pages where student can chose to delete the selected note. The application asks the student to confirm for deleting or not deleting the note.

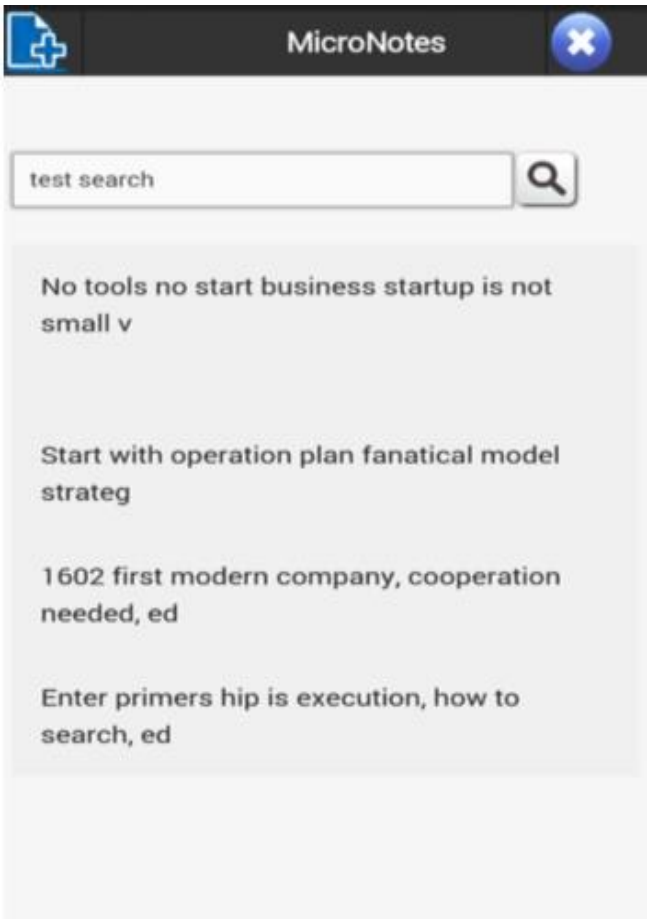


Figure 10. Search Note

Figure 10 shows the search function of the application where the student can search for any word by typing the word and clicking on search

```
<!DOCTYPE html>
<html class="no-js" lang="en-US" dir="ltr">
<head>
<title></title>
<!-- Foundation 5 styles -->
<link rel="stylesheet" type="text/css" href="../css/foundation.min.css">
<link rel="stylesheet" type="text/css" href="../css/normalize.css">
<!-- style-->
<link rel="stylesheet" type="text/css" href="../css/style.css">
<link rel="stylesheet" href="../js/jquery-ui.css" />
<link rel="stylesheet" type="text/css"
    href="../img/foundation-icons/foundation-icons.css" />
    <script src="../js/jquery-1.10.2.js"></script>
<script src="../js/jquery-ui.js"></script>
<script src="../js/jquery.mobile-1.2.0.min.js"></script>
<script src="../js/code.js"></script>
</head>
<body>
    <div class="row">
        <div class="off-canvas-wrap">
            <div class="inner-wrap">
                <div class="fixed">
                    <nav class="tab-bar" data-topbar data-options="is_hover: false">
                        <section class="left-small">
                            <input type="image" src="../img/back.png" onclick="s()" width="38
                        </section>
                        <section class="right tab-bar-section">
                            <h1>Micro Notes</h1>
                        </section>
                    </nav>
                </div>
                <aside class="left-off-canvas-menu">
                    <ul class="off-canvas-list" style="font-size: 12px;">
                        <li><label style="color: #FF8704;">MICRONOTE</label></li>

                        <li class="behind-link"><a href="#"><i
                                class="fi-page-search"
                                style="font-size: 18px; position: absolute; margin-top: -3px;
                        <li class="behind-link"><a
                            href="javascript:q=(document.location.href);void(open('file:///an
                                class="fi-home"></i>       
                                out</a></li>
                    </ul>
                </aside>
                <!--content here-->
                <div class="mobile-container">


                    <div class="modal-header">
                        <h2>New Note</h2>
                    </div>
```

Figure 11. Snippet from the application code

The Figures above (from Figure 1 to Figure 10) illustrated the operations that micro note taking provided to students. Figure 11 presented part of the coding process used to implement the application of micro note taking. Figure 12 below shows how the App works.

Figure 12. App sheet

Guidance for micro notes takers:

1. On the mobile phone open the **micro note taking** app.

2. Login using:

Username: provided by researcher
Password: provided by researcher

3. See the **App sheet** for instructions to how to use the app.

4. Take notes on the App when the video starts.

5. When the video ends:

    a. Turn-off the mobile phone.
    b. Fill-up the questionnaire.

Annex IV: Questionnaires for Evaluation

Questionnaire A

Based on your note taking experience and thinking of your future actions using pen and paper for taking notes activates, please indicate the degree to which you agree or disagree with the following statements.

#	Statement	Strongly Agree	Agree	Neutral	Strongly Disagree	Disagree
1	Pen-paper approach helped me to capture notes quickly					
2	Pen-paper approach helped me to manage the notes easily					
3	Pen-paper approach offered safe storage for the notes to be used later					
4	Pen-paper approach helped me to capture accurate notes including exact points mentioned in a lecture					
5	Pen-paper approach helped me to capture complete notes and include everything I need for studying					
6	Pen-paper approach helped me to remember the lecture easily in study time					
7	It was easy to read the notes for later study or use					
8	It was easy to access the notes for study					
9	Pen-paper helped me to find relevant notes to my questions while studying					

Questionnaire B

Based on your note taking experience and thinking of your future actions using the mobile micro note taking application for taking notes activates, please indicate the degree to which you agree or disagree with the following statements.

#	Statement	Strongly Agree	Agree	Neutral	Strongly Disagree	Disagree
1	Micro note taking approach helped me to capture notes quickly					
2	Micro note taking approach helped me to manage the notes easily					
3	Micro note taking approach offered safe storage for the notes to be used later					
4	Micro note taking approach helped me to capture accurate notes including exact points mentioned in a lecture					
5	Micro note taking approach helped me to capture complete notes and include everything I need for studying					
6	Micro note taking approach helped me to remember the lecture easily in study time					
7	It was easy to read the notes for later study or use					
8	It was easy to access the notes for study					
9	Micro note taking approach helped me to find relevant notes to my questions while studying					

Questionnaire C

Based on your note taking experience and thinking of your future actions using the word processor application for taking notes activates, please indicate the degree to which you agree or disagree with the following statements.

#	Statement	Strongly Agree	Agree	Neutral	Strongly Disagree	Disagree
1	Word processor approach helped me to capture notes quickly					
2	Word processor approach helped me to manage the notes easily					
3	Word processor approach offered safe storage for the notes to be used later					
4	Word processor approach helped me to capture accurate notes including exact points mentioned in a lecture					
5	Word processor approach helped me to capture complete notes and include everything I need for studying					
6	Word processor approach helped me to remember the lecture easily in study time					
7	It was easy to read the notes for later study or use					
8	It was easy to access the notes for study					
9	Word processor helped me to find relevant notes to my questions while studying					

Final Comparison Questionnaire D

Based on your note taking experience and thinking of your future actions using the mobile micro note taking application in comparison to the other note taking methods (i.e. pen and paper, word processor) please indicate the degree to which you agree or disagree with the following statements.

#	Statement	Strongly Agree	Agree	Neutral	Strongly Disagree	Disagree
1	Mobile micro note taking was easier to use compared to traditional/electronic approaches					
2	Mobile micro note taking offered safe storage for the notes in one place compared to current traditional/electronic approaches					
3	The 140 characters limit of mobile micro note taking helped me to generate better notes than traditional/electronic approaches.					
4	The 140 characters limit of mobile micro note taking helped me to not write every word in a lecture than traditional/electronic approaches					
5	Mobile micro note taking helped me to remember captured information more easier in exam time compared to current traditional/electronic approaches					
6	Mobile micro note-taking was more useful for exam revision compared to current traditional/current approaches					
7	Mobile micro note taking helped me to access the notes at anytime any place while studying compared to current traditional/electronic approaches					
8	Mobile micro note taking helped me to review all the notes quickly minutes before the exam compared to others					

Annex V: Further Results

The reliability of the questionnaire (Cronbach's alpha)

Variable	Number of Items	*Cronbach's Alpha*
Traditional pen and paper Questionnaire (A)	9	*0.892*
Mobile Micro note taking application Questionnaire (B)	9	*0.752*
Electronic Word Processor Questionnaire (C)	9	*0.923*
Final comparison Questionnaire (D)	8	*0.726*

In order to ensure reliability of the scale, *Cronbach's Alpha*, which is a common method used to measure internal consistency of scales in the literature, was used[135]. *Cronbach's alpha* test was used to measure the internal consistency (i.e. reliability) of all the items of the questionnaire used in the main experiment as it is one of the most frequently used for calculating reliability[136]. SPSS was used to check the internal consistency of the questionnaire items. The results above showed that the alpha coefficient for the overall items of the questionnaires ranged from 0.752 to 0.923. The results of the internal consistency (i.e. reliability) of the questionnaire used in this study demonstrated satisfactory reliability ranged between 0.7 and 0.9. According to Kline [137], when the outcome of the reliability test is between 0.7 and 0.9 it is considered to be a valid test.

Normality test for Traditional Pen and paper

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Traditional is normal with mean 2.933 and standard deviation 0.60.	One-Sample Kolmogorov-Smirnov Test	.478	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Normality test for Micro Note Taking

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of MicroNote is normal with mean 3.601 and standard deviation 0.56.	One-Sample Kolmogorov-Smirnov Test	.786	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Normality test for Electronic word processor

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Electronic is normal with mean 3.025 and standard deviation 0.87.	One-Sample Kolmogorov-Smirnov Test	.995	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.